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PIPE LINE

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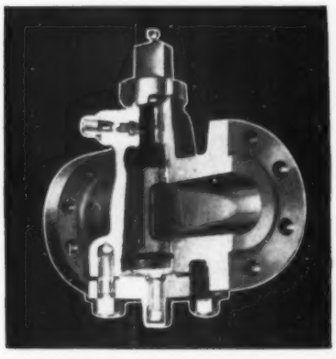

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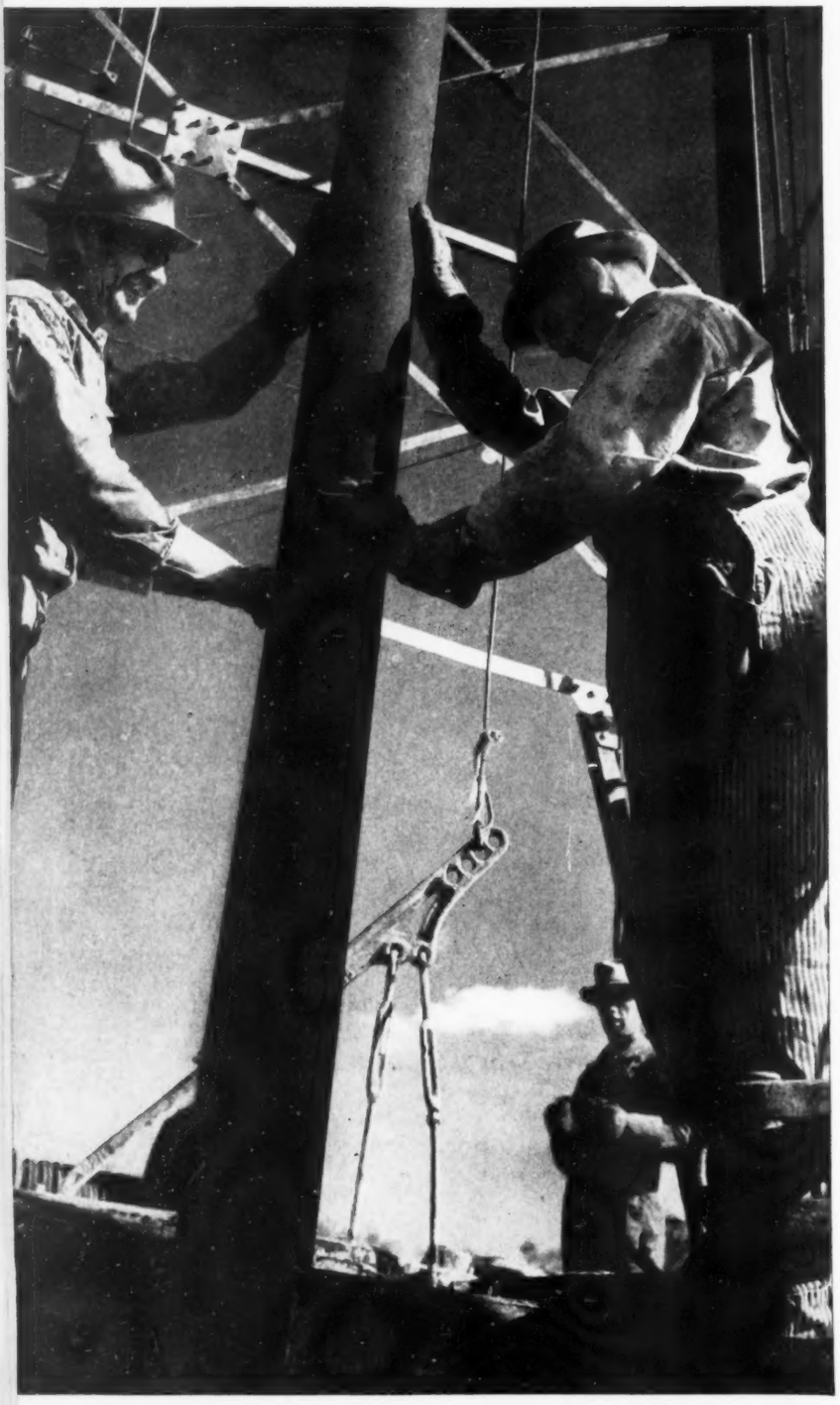

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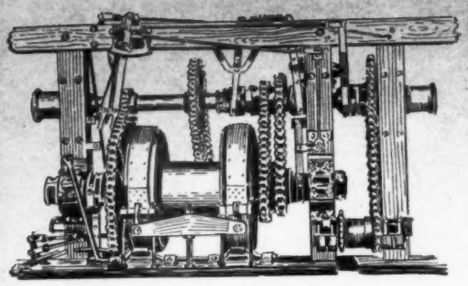

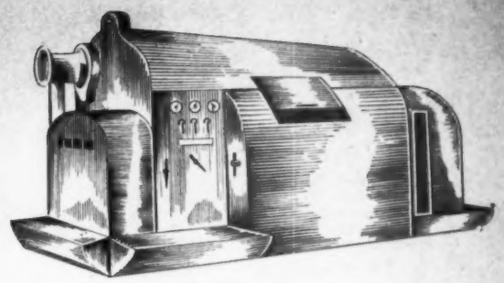

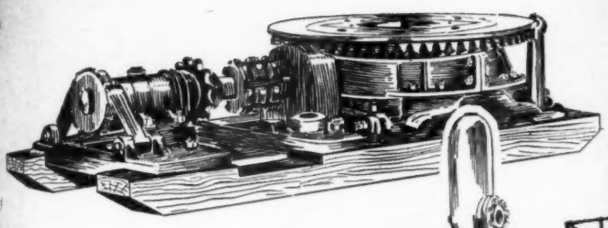

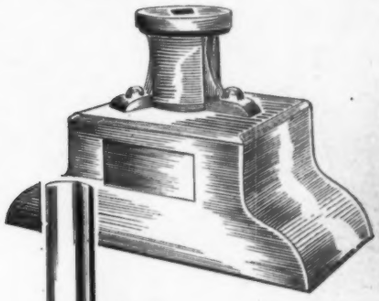

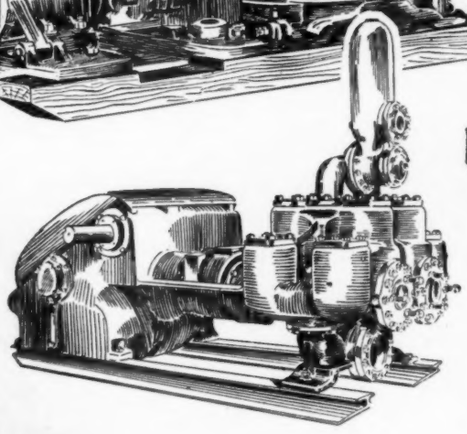

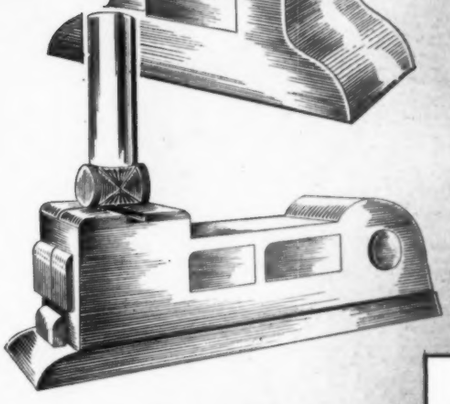

**YESTERDAY** **TOMORROW**

**TODAY**

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November, 1942

# THE Petroleum Engineer

VOL. XIV No. 2

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MEMBER A. B. C.—A. B. P. (The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N.

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# TEXACO DEVELOPMENT CORPORATION

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# The Course of Oil

by K. C. SCLATER

## PROBLEM OF RESERVES

Something has to be done about increasing the nation's petroleum reserves. But what? That is the disconcerting problem confronting officials of the O.P.C.

Bearing on the problem are these facts: first, the discovery of adequate new oil reserves is lagging far behind national needs; second, the supply of materials available is rapidly diminishing; third, the shortage of man-power is becoming acute.

Officials of the O.P.C. at the A.P.I. meeting in Chicago this month emphasized the gravity of the situation. There is no denying the fact that the outlook is grim.

Just how serious is the situation with respect to new reserves is evident from an examination of the record of the last three years. During that time, to quote Deputy Petroleum Coördinator Davies, "In the past three years we drilled in this country an average of 2,963 wildcats per year, and discovered an average of 387,000,000 barrels in new fields. In the preceding three years, we drilled fewer wildcats by twenty-two percent, yet discovered seventy-eight percent more oil. It would seem that the bonanza days in oil have pretty well passed."

According to W. B. Heroy, Director of Reserves in the O.P.C., "Assuming a current production of 4,000,000 barrels per day, there must be made available from new discoveries and development in 1943 about 400,000 barrels per day; in 1944 about 800,000 barrels; in 1945 about 1,200,000 barrels; and in 1946, 1,600,000 barrels per day." He also points out that "Four hundred thousand barrels per day is more than the current production of the East Texas field; about the combined average daily production in 1941 of the next six largest fields in the country."

As for materials, the situation is no less disturbing. Allotments by the W.P.B. to the petroleum industry for oil production, natural gas, and natural gasoline operations, have been drastically reduced for the last quarter of 1942. The industry's estimated requirements were 422,802 tons of carbon steel, 35,290 tons of alloy steel, and 673,258 pounds of copper and copper base alloys. Shortages are so great that the W.P.B. was compelled to pare allotments to 194,000 tons of carbon steel or 45.9 percent of requirements, 536 tons or 1.5 percent of alloy steel needs, and 305,000 pounds or 45.3 percent of copper and copper base alloy needs.

As for man-power, W. B. Heroy reports that "The requirements of the armed forces have made heavy inroads on the personnel of the industry engaged in oil finding. Many companies have lost from a quarter to a half of their engineers, geologists, and geophysicists. Drilling contractors have had similar losses from their crews."

These are the stark facts. What solutions are in prospect?

In regard to exploratory drilling, Don Knowlton, Director of Production in the O.P.C., warns that "Selective drilling is bound to come. And when it does, you will find drilling in some areas spread out to one well to 160 acres—maybe more—just enough drilling to define field limits and let us know how much oil we can plan on recovering. Materials are just that scarce." What is meant by selective drilling? Just this: the governing requirements in the selection of wildcat locations to be drilled will be the availability of transportation and refining facilities, the nearness to centers where oil products are needed, and—what may be difficult to estimate but is none the less important—the probable yield of oil per unit of material consumed.

Efforts to increase reserves must not stop at wildcat drilling, but must be extended to present producing fields. In this connection, a significant pronouncement comes from Deputy Petroleum Coördinator Davies: "There is great opportunity for improved over-all operation through the promotion of unit plans within the industry. In production, as in other branches of the industry, there is need for more consolidated operation during the emergency. Savings of the most important kind can be accomplished; savings in material, in man-power, and above all else in oil itself. The industry has an opportunity during the war to coöperate which is denied it in ordinary times. I believe it has not yet taken full advantage of this fact. I urge the necessity for this course and emphasize with you again the desirability of it from the industry's own long-range point of view."

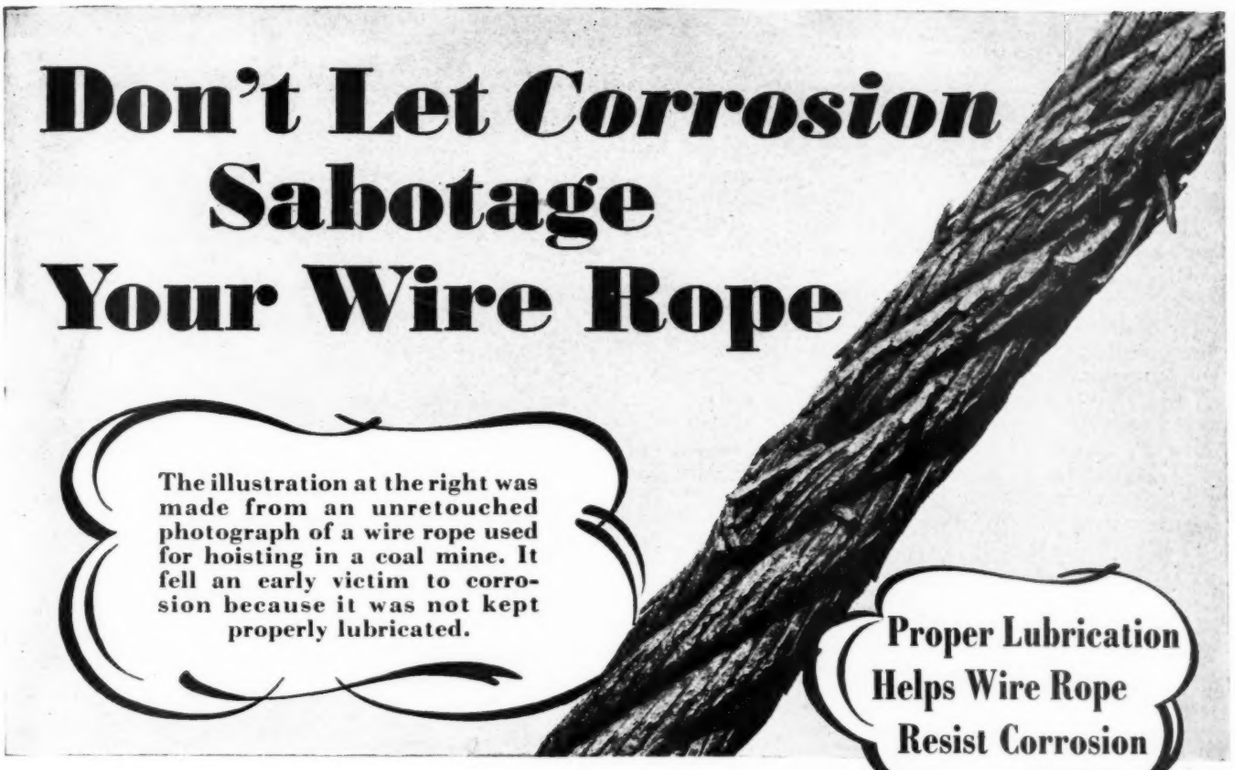
What about materials? To aid in overcoming material shortages, there must be a distribution of inventories among members of the industry. This necessity was emphasized in no uncertain terms by G. W. Orton, Director of Materials in the O.P.C. Inventory utilization and redistribution is second only in importance to the conservation of oil resources. To aid in coping with the man-power problem, W. B. Heroy suggests that "Technical men can often be relieved of executive and administrative responsibilities and routine and allowed to concentrate on exploratory problems. The preparation of extended reports, desirable as a record in normal times, can be largely dispensed with and short statements of conclusions relied upon."

It is quite likely that existing regulations will be amended to permit a stricter control of well drilling, to allow reconditioning and recompletion of existing wells, and to permit transfers of equipment among co-tenants of oil and gas leases.

The P.I.W.C. has rejected as unsound in principle, subsidies to encourage drilling. A greater impetus to increasing the nation's production of petroleum and discovery of new reserves, it is asserted, would result from an increase in the price of crude, from an assurance that the percentage depletion allowance would not be interfered with, and a further assurance that the right to expense intangible drilling costs would be continued.

Tremendous operational problems must therefore be overcome if readily available sources are to be maintained at a level adequate for war needs.

# Don't Let *Corrosion* Sabotage Your Wire Rope



The illustration at the right was made from an unretouched photograph of a wire rope used for hoisting in a coal mine. It fell an early victim to corrosion because it was not kept properly lubricated.

**Proper Lubrication Helps Wire Rope Resist Corrosion**

CORROSION is an enemy saboteur that is constantly trying to destroy your wire rope. Unless combated by proper lubrication, normal rope life is greatly shortened and a serious hazard to safety created.

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The right kind of lubricant to use and the frequency with which it should be applied depends upon the conditions under which your rope is operating. When in doubt, we suggest you consult with an experienced wire rope manufacturer.

Now that steel is so urgently needed for so many implements of war, the more "work hours" you can get out of your wire ropes, the more steel you save for other vital purposes. So in all earnestness we repeat *—Don't let Corrosion sabotage your wire rope.*

**• IMPORTANT •**

An idle wire rope is more vulnerable to corrosion than one in use, so be sure to give your ropes the protection of a good lubricant when they are not in service.


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# Highlights IN OILDOM

## Wage-Hour Act Held Applicable

The United States Supreme Court has ruled that the Wage-Hour Act applies to employees of the Warren-Bradshaw Drilling Company, operating in the Texas Panhandle area, a case that has been in the courts for some time. The decision, delivered by Justice Frank Murphy, gives further interpretation to this important legislation.

The Justice Department contended that the act applied to employees of the company, who were awarded $4190 as overtime compensation by the Fifth Federal Circuit Court. As explained by the Justice Department, the drilling company contracted with the owners or lessees of oil lands to "drill holes to a depth short of the oil sand stratum", after which others undertook to bring-in the well. This service, the Justice Department contended, was so closely related to production for interstate commerce as to warrant considering it a part of that production.

## Drilling Exception Sought for Texarkana Pool

The State of Arkansas, acting through the Oil and Gas Commission, has prepared, in accordance with OPC Form PD-214b, an application for an exception under Conservation Order M-68, as amended, for the development of the Texarkana pool of Miller County, Arkansas, upon the basis of 1 well to each 160 surface acres in lieu of 1 well to each 640 surface acres.

The Texarkana pool is a gas condensate pool. The Commission seeks to have this pool developed on a basis of 1 well to each governmental sub-division of 160 acres and proposes to communitize any separately owned tracts of land embraced within a unit. The Commission has found from evidence adduced at a public hearing and from studies of its own engineering staff that it is possible for the pool to contain as much as 30,000,000 bbl. of recoverable condensate associated with 350,000,000,000 cu. ft. of natural gas; that past experience indicates the pool will be of a water-drive type, thus precluding the necessity of cycling or repressuring operations; that the natural gas, although unusual, presents no problems from the standpoint of usage that have not been overcome in the other gas condensate pools of the state. Experience has proved that none of the gas condensate pools discovered and developed in southern Arkansas in the past could have been properly developed on a basis of 1 well to 640 surface acres, officials of the Commission state.

Because the Commission believes that the natural gas recoverable from the Texarkana pool could be of value to the national war effort, particularly in an area where more than $500,000,000 have been expended on industry and military facilities, the early approval of the War Production Board of the application is being sought.

## Want Used Steel Tanks

A plea for used steel tanks, of from 500 to 80,000 bbl. capacity, has been made by the Los Angeles office of the U. S. Engineer. The tanks are to be used to store aviation gasoline at airports now under construction, and are urgently needed because the War Production Board has prohibited the use of new steel plates for such purposes.

According to the Engineer's office, almost any type of steel tank can be used, and will be purchased on the spot by the government. Dismantling, if necessary, transportation, and erection at the new site will all be handled by the Engineer's office. Light gauge tanks will be used as liners and encased in concrete, whereas heavier gauge will be used without the concrete casing.

W. E. Buescher and R. C. Sharp are the engineers in charge of the program. They are in the branch U. S. Engineer Office at 7th and Bixel Streets, Los Angeles, California, telephone TUcker 1311, extension 629.

## More Light Permitted for Night Drilling

A temporary variance from the dimout regulations, to permit uninterrupted drilling and servicing of oil wells, has been obtained by the Oil Industry Protection Committee of California from the Ninth Regional Defense Board. The variance permits the use of a total of 3000 watts of light for drilling rigs and 1500 watts for each well being serviced, provided no light is emitted above the horizontal plane of the fixture.

In addition, the variance, which expires on November 25, unless sooner revoked, permits the use of light directed up into the sky during actual pulling of rods and tubing from wells, provided the wattage of the light or lights does not exceed a total of 200. The Oil Industry Protection Committee is at present engaged in formulating a recommendation for a permanent variance, which will probably be along the lines of the temporary variance now in effect.

In requesting the variance, the Committee pointed out that under the terms of Proc. No. 10, issued by Gen. J. L. DeWitt, safe and efficient conduct of drilling and producing operations at night were practically an impossibility. The Committee explained that it was extremely unsafe to conduct operations at night with less than one foot candle of illumination because of the speed and power of machinery and the fact that equipment, tools, and surroundings generally are very dark in color.

At present there are approximately 102 wells that would be affected by the order. In addition, there are about 16,000 producing wells in the state, most of which operate at night without servicing, but which might require night servicing in an emergency.

The defense board in granting variation from the order made it clear that lights must be shielded so no direct rays are emitted above the horizontal, except that lights visible from above, but not from the sea, may be used while pipe or rods are being run or pulled. Total power of such lights must be limited to 200 watts and outdoor ground illumination kept to minimum so far as possible without reducing the efficiency of protection. The order, the board stated, is subject to revocation at any time.

## Urges Parity Price for Crude Oil

Ernest O. Thompson, chairman of the Texas Railroad Commission, early this month urged Price Administrator Leon Henderson to supplement depleted petroleum reserves by allowing the price of crude oil to advance to a parity level.

"Certainly a commodity as important to the war effort as oil has just as much right to a parity price as has any other product," Thompson declared, saying:

"There is no doubt in my mind whatever that if the Price Administrator will allow the price of crude to come to parity with the other basic commodities, we can promptly uncover enough new flush fields to make possible the production of 5,000,000 bbl. per day over a sustained period."

Thompson pointed out that "an average increase in the price of oil of 25 cents a bbl. in the past has always brought about an immediate increase in drilling of wildcat wells and has always in the past brought about the discovery of new pools."

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4 Spacing band centers glass and prevents contact with metal.

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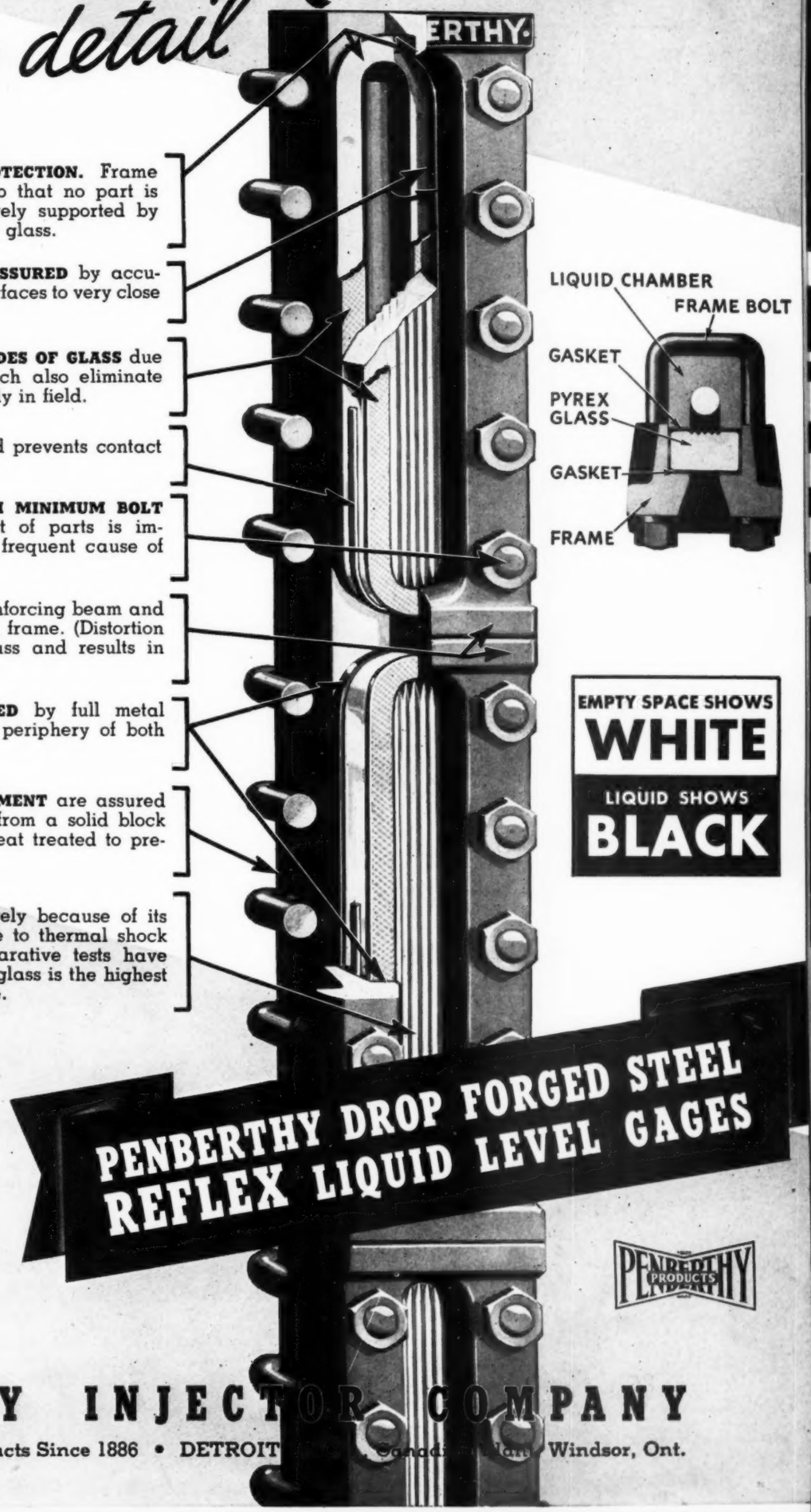


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# MAJOR *Refining* ACTIVITIES

THE Oklahoma Corporation Commission has authorized the Cabot Carbon Company, represented by E. L. Green, Jr., Pampa, Texas, to construct a furnace-type carbon black plant near Guymon, Oklahoma, utilizing gas from the Panhandle area and Hugoton gas field. The plant will use 10,000,000 cu. ft. of gas per day in its operation.

Carbon black, furnace type, has been placed under a complete allocation system, which was effective November 1, by the director general for operations in General Preference Order M-244. Acknowledged one of the important ingredients used in compounding synthetic rubbers, reports state that the facilities for producing carbon black are not sufficient for present and future needs.

The only exemption to purchasers is the purchasing, delivery, and use of 100 lb. or less of furnace-type carbon black to any one person in any one month. Form PD-600 must be filed by persons seeking authorization to accept delivery and Form PD-601 filed by persons seeking authorization to make delivery.

Expansion of the Amarillo, Texas, U. S. Bureau of Mines' helium plant and construction of four other plants in Colorado, Kansas, Utah, and New Mexico, being carried on under five separate appropriations totaling $16,775,000, is continuing despite the War Production Board order stopping construction of projects under supervision of several government agencies. It is expected that the work will continue at least until some agreement has been reached by the Department of interior and the WPB.

According to Harold L. Ickes, secretary of the Department of the Interior, the order had been issued without consultation with the affected agencies and under strict interpretation of the order work would cease on the projects. Due to the importance of the projects to the prosecution of the war, Ickes did not stop the work, but notified Army and Navy authorities and requested that the WPB literally interpret the order. The WPB has agreed to permit continuance of the work on the projects while examining a list of "essential" and "nonessential" projects before taking action to close jobs.

An order has been issued by the Louisiana Department of Conservation authorizing construction of a cycling plant in the Erath field. The plant will be owned and operated exclusively by The Texas Company and cost approximately $3,000,000. Construction work is to begin immediately with completion of the project tentatively set for the middle of 1943.

Gas processed by the plant will be supplied on a coöperative basis. It will be drawn from several properties in the field.

A high priority rating on construction materials for the plant is due to the recovery of critical petroleum products in the operation.

Construction will begin in December on a carbon black plant for the J. M. Huber Corporation at a site about three miles west of Borger, Texas. The plant will produce about 6,000,000 lb. of carbon black per year. Decision to build the plant was due to the lack of the material that is important in the compounding of synthetic rubber.

Two polymerization plants, to be operated by the Firestone Tire and Rubber Company, will process ingredients for synthetic rubbers produced by the Standard Oil Company and Cities Service Company plants at Baton Rouge and Lake Charles, Louisiana.

H. K. Ferguson Company, Cleveland, Ohio, has been awarded the contracts for construction of the polymerization plants by the Defense Plant Corporation, subsidiary of the Reconstruction Finance Corporation, which will own the installations. The plant owned by the Cities Service Company is a new plant and will be one of the most modern in the country for the production of synthetic rubber ingredients.

The butadiene plant near the Houston, Texas, refinery of the Sinclair Refining Company for Sinclair Rubber, Inc., is under construction. The plant is expected to produce 50,000 tons of butadiene per year. Feed stock for the plant is to be supplied jointly by the Sinclair Refining Company, Pan American Refining Corporation, and the Crown Central Petroleum Corporation. The Goodyear Tire and Rubber Company will process and polymerize the butadiene produced by the plant into synthetic rubber.

Styrene, an all-important ingredient of synthetic rubber, will be supplied by a plant now being built and operated by Monsanto Chemical Company at Texas City. Operation of the Sinclair plant is expected to begin about the middle part of 1943.

A proposal for the construction of butadiene and styrene plants in California is understood to have been filed with William M. Jeffers, rubber director, by Henry J. Kaiser, prominent West Coast shipbuilder.

The proposal included the use of benzol from the coke ovens of the Kaiser steel plant soon to begin production near Fontana, California, and alcohol produced at local wineries and the Monarch Brewing Company of Los Angeles. It has been reported that enough benzol and alcohol is available for production of 10,300,000 lb. of styrene and 34,400,000 lb. of butadiene per year, which would yield about 20,000 tons of Buna S rubber. It is reported that increasing the size of the Fontana plant would double the amount of benzol. Jeffers is said to have the proposal under consideration.

**Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks**
**Week Ended October 31, 1942**
**A.P.I. Figures**

(Figures in thousands of bbl. of 42 gal. each)

| DISTRICT | Percent Potential Capacity Reporting | Daily Avg. Crude Runs to Stills | Percent Operated of Total Capacity Reporting | Total Motor Fuel Stocks | Total Gas and Fuel Oil Stocks |
|---|---|---|---|---|---|
| *Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas, and Inland Texas | 88.2 | 1,631 | 66.8 | 37,797 | 45,692 |
| Appalachian | 84.8 | 159 | 90.3 | 2,685 | 1,247 |
| Ind. Ill., Ky. | 84.9 | 764 | 95.0 | 13,752 | 9,265 |
| Okla., Kans., Mo. | 80.1 | 347 | 83.4 | 6,235 | 3,277 |
| Rocky Mountain | 48.0 | 103 | 70.1 | 1,643 | 994 |
| California | 89.0 | 727 | 89.0 | 17,047 | 67,415 |
| TOTAL U. S.—B. OF M. BASIS OCT. 31, 1942 | 85.9 | 3,731 | 77.7 | (a)79,159 | 127,890 |
| TOTAL U. S.—B. OF M. BASIS OCT. 24, 1942 | 85.6 | 3,776 | 78.7 | 79,545 | 126,640 |
| U. S. B. OF M. BASIS NOV. 1, 1941 | ..... | 4,087 | ..... | 82,303 | 151,116 |

(a) Finished, 70,070,000 bbl.; unfinished, 9,089,000 bbl.
*At the request of the Office of Petroleum Coordinator.

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# MAJOR *Oil Field* ACTIVITIES

THE Falcon-Seaboard Drilling Company and Lario Oil and Gas Company have opened a new pool in McPherson County, Kansas. The third new pool of the year for the county was discovered by the well, Bean Estate No. 1, CW½ SL SW of 25-17-4w, about two miles southwest of the Lindsborg area. Completed in the Viola lime, the well is showing for a commercial producer. Two other formations, the Simpson sand and Arbuckle dolomite, were found dry. Topped at 3402 ft., the Viola indicated good production on a drill-stem test.

Curtis No. 1, is apparently a discovery well in Stafford County, Kansas, for a new pool. The well drilled in CSL SW NW of 6-22-13w, near Seward is owned by the Vickers Petroleum Company. Good oil shows were found in the Lansing, Viola, and Simpson zones. The hole filled 2000 ft. with oil from the Simpson sand at 3646 ft. to 3692 ft. The Viola was from 3628 to 3645 ft. and the Lansing from 3104 to 3105 ft.; 3465 to 3464 ft., 3501 to 3503 ft., 3514 to 3525 ft., and from 3537 to 3542.

Technologists of The Atlantic Refining Company believe the well, Whistler No. 1, drilled in NW SW SE of 18-11-5e, will be completed for a production of from 750 to 1000 bbl. per day. The well has extended the northeast Shawnee pool of Pottawatomie County, Oklahoma. Production was obtained from the Wilcox sand from a depth of 4849-53 ft. After the plug had been drilled and the oil and water load removed, the well was swabbed down and made 50 bbl. per hour for three hours before being shut in.

First completion by The Sinclair Prairie Oil Company in Kentucky was the well, Charles D. Burbank No. 1, 330 ft. from the NE and NW lines of lot 12, Burbank survey in Henderson County of northwest Kentucky. The well was drilled to 2309 ft. in the Cypress sand and tested for 338 bbl. of oil the first 24 hours. Reports state that locations have been staked for wells Nos. 2 and 3, 330 ft. from the NE and SW lines and 330 ft. from the NE and SE lines, of lot 12, respectively.

A new sand has been brought into production on the east flank of the Lolita field in Jackson County, Texas. L. Ranch Company No. 1, drilled by the Tide Water Associated Oil Company, was completed with perforations at 5941 ft. to 5945 ft. The well was later plugged-back and perforated from 5716 ft. to 5720 ft. to flow 14 bbl. per hour through ¼-in. and ⅜-in. chokes with 775-lb. working pressure. The latest well drilled in the field, its location is in the northeast corner of lot 128 of LaWard Farms, subdivision of I.-G. N. survey 19. The 5½-in. production string is cemented at a total depth of 5964 ft.

Louisiana Furs No. C-1, Chenier au Tigre prospect, section 21-16s-2e, Vermillion Parish, Louisiana, made first test in perforations deep in Miocene section at 11,582 ft. to 11,586 ft. for a production that was entirely gas. The operator, Union Oil Company of California, is preparing a second test on the well after squeeze cementing the perforations in the Miocene and plugging back. The hole was bottomed at 11,985 ft. in shale.

## AVERAGE CRUDE OIL PRICES

| | | | |
|---|---|---|---|
| California | | Louisiana | |
| Kettleman Hills | $1.23-1.29 | Rodessa | $ .88-1.20 |
| Playa Del Rey | .80- .87 | Gulf Coast | .93-1.36 |
| Coalinga | .73-1.13 | North Louisiana | .98-1.30 |
| Wilmington | .68-1.24 | | |
| Montana | 1.00-1.15 | Illinois | 1.22-1.37 |
| Wyoming | .45-1.15 | Kentucky | 1.32-1.43 |
| Colorado | 1.05-1.07 | | |
| New Mexico | .70-1.15 | Indiana | .85-1.25 |
| Texas | | Ohio | |
| North Central | .97-1.21 | | |
| Panhandle | .70-1.12 | Lima | 1.50-1.60 |
| West Texas | .80-1.27 | Michigan | 1.24-1.44 |
| Gulf Coast | .93-1.48 | | |
| Darst Creek | 1.14 | Pennsylvania | |
| East Texas | .80-1.27 | Bradford | 3.00 |
| Talco | .79 | Southwest | 2.65 |
| Kansas | .93-1.25 | Eureka | 2.59 |
| Oklahoma | .75-1.25 | Buckeye | 2.55 |
| Arkansas | .94-1.36 | Corning | 1.31 |

## DAILY AVERAGE CRUDE OIL PRODUCTION
### Data Supplied by A.P.I.
(Figures in bbl. of 42 gal. each)

| | [1]O.P.C. Recommendations October | Week Ended Oct. 31, 1942 | Week Ended Aug. 26, 1942 | Week Ended Nov. 1, 1941 |
|---|---|---|---|---|
| Oklahoma | 417,000 | [2]368,050 | 368,550 | 436,400 |
| Kansas | 294,000 | [2]297,700 | 296,900 | 237,350 |
| Nebraska | 3,500 | [2] 3,450 | 3,300 | 6,450 |
| Panhandle Texas | | 98,500 | 84,950 | 80,100 |
| North Texas | | 140,000 | 137,950 | 136,950 |
| West Texas | | 214,000 | 217,100 | 285,600 |
| East Central Texas | | 90,200 | 86,450 | 85,850 |
| East Texas | | 362,000 | 362,400 | 369,700 |
| Southwest Texas | | 167,700 | 165,300 | 220,000 |
| Coastal Texas | | 321,000 | 326,200 | 291,750 |
| TOTAL TEXAS | 1,407,600 | 1,393,400 | 1,380,350 | 1,469,950 |
| North Louisiana | | 98,150 | 98,500 | 80,750 |
| Coastal Louisiana | | 231,000 | 231,550 | 261,400 |
| TOTAL LA. | 337,200 | 329,150 | 330,050 | 342,150 |
| Arkansas | 79,500 | 73,350 | 73,000 | 72,400 |
| Mississippi | 50,000 | [2] 69,200 | 73,400 | 63,300 |
| Illinois | 280,000 | 263,600 | 262,350 | 419,800 |
| Indiana | 19,000 | [2] 15,900 | 16,750 | 18,000 |
| Eastern (Not incl. Ill. & Ind.) | 107,400 | 97,950 | 95,450 | 99,450 |
| Michigan | 65,700 | 60,200 | 63,000 | 57,950 |
| Wyoming | 90,800 | 89,750 | 94,950 | 79,700 |
| Montana | 24,400 | 21,850 | 21,700 | 20,000 |
| Colorado | 7,000 | 7,000 | 6,600 | 5,750 |
| New Mexico | 101,100 | 99,500 | 97,900 | 116,450 |
| TOTAL EAST OF CALIF. | 3,284,200 | 3,190,050 | 3,184,250 | 3,445,100 |
| California | 782,000 | 711,100 | 724,800 | 626,100 |
| TOTAL U. S. | 4,066,200 | 3,901,150 | 3,909,050 | 4,071,200 |

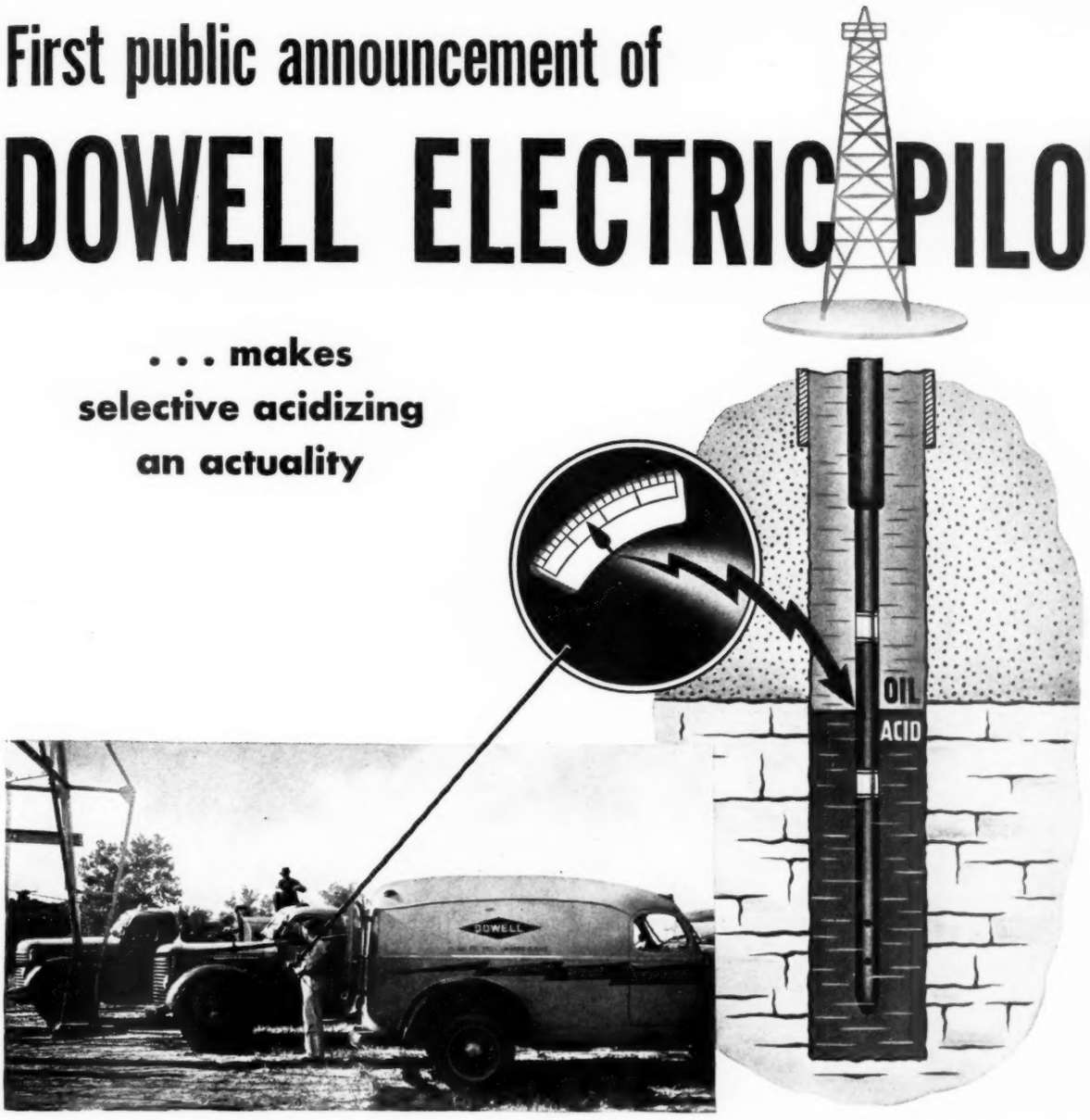
[1]O.P.C. recommendations and state allowables represent the production of all petroleum liquids, including crude oil, condensate and natural gas derivatives recovered from oil, condensate and gas fields. Past records of production indicate, however, that certain wells may be incapable of producing the allowables granted, or may be limited by pipeline proration. Actual state production would, under such conditions, prove to be less than the allowables. The Bureau of Mines reported the daily average production of natural gasoline and allied products in July, 1942, as follows: Oklahoma, 28,300; Kansas, 4,300; Texas, 98,900; Louisiana, 19,000; Arkansas, 2,900; Illinois, 8,900; Eastern, (not including Illinois and Indiana) 7,800; Michigan, 200; Wyoming, 2,200; Montana, 200; New Mexico, 5,800; California, 41,000.

[2]Oklahoma, Kansas, Nebraska, Mississippi, Indiana figures are for week ended 7 a. m., October 28th.

# First public announcement of

# DOWELL ELECTRIC PILOT

**. . . makes selective acidizing an actuality**




## DOWELL DEVELOPMENT PROVIDES NEW MEASURE OF CERTAINTY IN WELL TREATING

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Wells with high gas-oil ratios, high water-oil ratios, two or more pay zones, sands exposed above or below limestone, leaky casings or those that have been deepened are perfect subjects for the Electric Pilot service in conjunction with a Dowell acidizing treatment.

Special literature giving detailed information on how Dowell provides Selective Acidizing with the Electric Pilot is available from Dowell field men or by writing to Dowell's Tulsa office.

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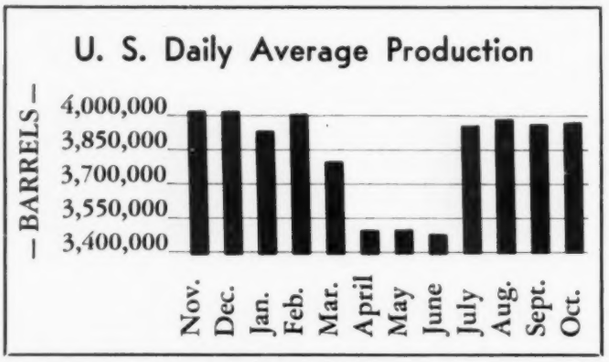
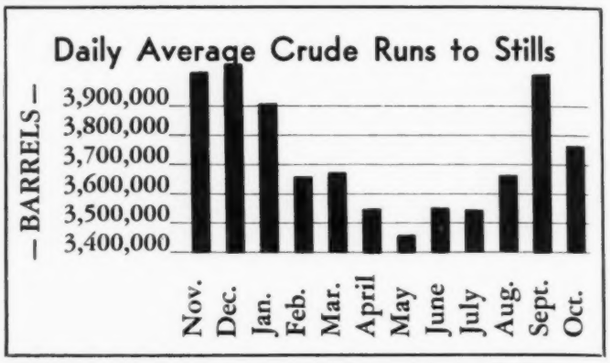
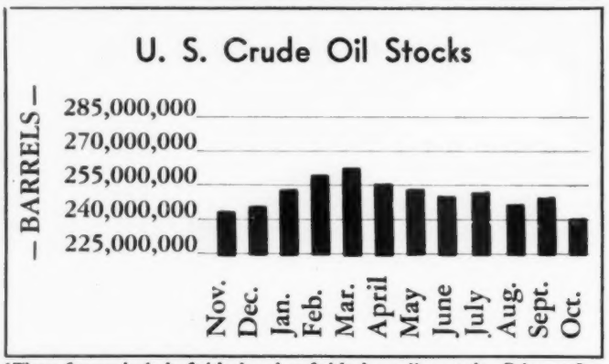
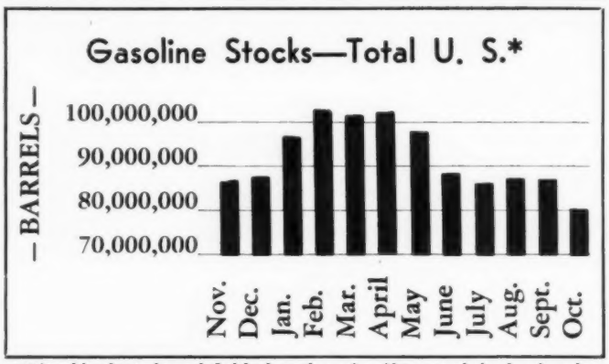
# PETROLEUM *Statistics* AND FIELD *Operations*




*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

## Summarized Operations in Active Fields for October, 1942

| Fields | Completions | Producers | Rigs | Drilling Wells | Depth of Production | No. Casing Strings | Gravity of Oil | Type of Tool Used |
|---|---|---|---|---|---|---|---|---|
| TEXAS | | | | | | | | |
| East Texas | 34 | 29 | 3 | .... | 3500-3700 | 2 | 40 | Rotary |
| Gaines County | 6 | 5 | 5 | .... | 4400-5584 | 2 | 22-35 | Rotary |
| Hockley County | 14 | 11 | 3 | .... | 4800-6850 | 2 | 20-30 | Rotary |
| Ector County | 7 | 5 | 5 | .... | 3675-4377 | 2 or 3 | 32-36 | Rotary |
| Panhandle | 28 | 21 | 4 | .... | 1700-3900 | 2 | 40 | Rot.-Cab. |
| Nueces County | 9 | 6 | 6 | .... | 3922-5878 | 2 or 3 | 21-54 | Rotary |
| K. M. A. Field | 6 | 4 | 4 | .... | 3730-3935 | 2 | 42-43 | Rot.-Cab. |
| Hawkins Field | 24 | 19 | 5 | .... | 4495-4912 | 2 | 19-29 | Rotary |
| OKLAHOMA | | | | | | | | |
| Okfuskee County | 6 | 5 | 7 | 5 | 2150-4125 | 2 or 3 | 38 | Rotary |
| KANSAS | | | | | | | | |
| Russell County | 20 | 16 | 6 | .... | 2926-3435 | 2 and 5 | 32-37 | Rot.-Cab. |
| Rice County | 6 | 4 | 5 | .... | 3222-4085 | 2 and 5 | 42-48 | Rot.-Cab. |
| Barton County | 13 | 9 | 2 | .... | 3290-3518 | 2 | 39-42 | Rot.-Cab. |
| ILLINOIS | | | | | | | | |
| Central Illinois | 172 | 161 | 79 | 126 | 1425-4100 | 2 | 36-38 | Rot.-Cab. |
| NEW MEXICO | | | | | | | | |
| Lea County | 17 | 15 | 5 | 4 | 3150-4030 | 2 | 30-34 | Rot.-Cab. |
| CALIFORNIA | | | | | | | | |
| Kern County | 8 | 6 | 4 | 4 | 1840-11,450 | 3 or 4 | 14-30 | Rotary |
| Wilmington County | 7 | 4 | 3 | 6 | 3500-4000 | 2 and 3 | 18-20 | Rotary |

## Field Activities by States for October, 1942

| State | Completions | | Producers | | Locations | | Rigs | | Drilling Wells | | Production, 1941 (In Barrels) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | October | September | October | September | October | September | October | September | October | September | |
| Arkansas | 18 | 17 | 14 | 13 | 13 | 10 | 6 | 4 | 18 | 14 | 29,263,000 |
| California | 50 | 43 | 44 | 154 | 22 | 31 | 33 | 79 | 33 | 114 | 230,271,000 |
| Illinois | 172 | 167 | 161 | 153 | 61 | 55 | 79 | 68 | 126 | 97 | 131,272,000 |
| Indiana | 31 | 28 | 23 | 21 | 17 | 19 | 6 | 6 | 14 | 18 | 6,998,000 |
| Kansas | 139 | 142 | 128 | 133 | 79 | 87 | 21 | 15 | 28 | 46 | 82,733,000 |
| Kentucky | 6 | 2 | 4 | 1 | 4 | 2 | .... | .... | .... | .... | 4,790,000 |
| Louisiana | 182 | 182 | 171 | 160 | 58 | 68 | 13 | 13 | 18 | 13 | 116,038,000 |
| Michigan | 26 | 30 | 20 | 23 | 9 | 16 | 10 | 10 | 7 | 10 | 16,312,000 |
| Mississippi | 5 | 4 | 3 | 2 | .... | .... | .... | .... | .... | .... | 15,528,000 |
| Montana | 13 | 7 | 9 | 8 | .... | .... | .... | .... | .... | .... | 7,440,000 |
| Nebraska | 4 | 5 | 1 | 3 | 3 | 7 | .... | .... | .... | .... | 1,785,000 |
| New Mexico | 46 | 46 | 43 | 41 | 36 | 36 | .... | .... | .... | .... | 39,109,000 |
| New York | 69* | 65* | 65* | 58* | 72 | 56 | .... | .... | .... | .... | 5,180,000 |
| Ohio | 41 | 40 | 35 | 37 | 34 | 27 | .... | .... | .... | .... | 3,342,000 |
| Oklahoma | 131 | 122 | 117 | 115 | 37 | 33 | 7 | 7 | 81 | 67 | 154,817,000 |
| Pennsylvania | 118* | 114* | 109* | 108* | 122 | 98 | .... | .... | .... | .... | 16,700,000 |
| Texas | 501 | 483 | 427 | 420 | 318 | 300 | 381 | 357 | 362 | 328 | 501,745,000 |
| West Virginia | 27 | 35 | 79 | 22 | 14 | 16 | 6 | 7 | 14 | 7 | 3,418,000 |
| Wyoming | 1 | .... | 1 | .... | 2 | .... | 1 | .... | 1 | .... | 29,952,000 |
| Total | 1943 | 1532 | 1454 | 1472 | 901 | 863 | 563 | 566 | 702 | 723 | 1,398,485,000 |

*Includes water-intake and pressure wells.

# if

# OIL WILL WIN THE WAR

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Photographs on this page of O-C-T Christmas Trees illustrate a few of the numerous types of O-C-T Casing Heads, Tubing Heads, Fittings, Chokes, and Valves. Your request for detailed information on any O-C-T product will be given immediate attention.



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# MAJOR *Pipe Line* ACTIVITIES

EXTENSION of the world's largest oil pipe line from southern Illinois to the East Coast will begin in December as the result of allocation of the necessary steel by the War Production Board, Petroleum Coördinator for War Harold L. Ickes has announced.

The 857-mile, $60,000,000 extension will assure a direct daily pipe-line delivery of 300,000 bbl. of crude oil or products to the eastern seaboard. Actual work awaits only the completion of the leg now being laid between Longview, Texas, and Norris City, Illinois, and the transfer of construction crews to work sites along the routes to the East Coast.

The line all the way from Texas to the East Coast, now authorized, is virtually identical with the line recommended by Coördinator Ickes in July, 1941. Difficulty in obtaining material did not permit the construction to begin at that time.

Laying of the 531-mile Longview-Norris City section was begun in August and is scheduled for completion in December.

In a statement, Coördinator Ickes said:

"The allocation of the 219,000 tons of steel necessary to continue the line to the East Coast is recognition of the fact that only by having such a pipe line can the Atlantic seaboard be provided with a dependable additional supply of the petroleum so essential to the successful prosecution of the war.

"The oil that this line will deliver to the refineries of the New York-Philadelphia area will benefit not only our war industries, but, more important still, it will make possible the release of many ocean-going tank ships from the long water haul from Gulf Coast ports. This fact alone is justification enough for the extension of the line at this time, for it will aid us materially in carrying the war to the enemy. In fact, so important do I regard the function the pipe line can perform in the winning of this war that it is perfectly clear to me that we must not only complete this line with the utmost possible dispatch, but that we must immediately give consideration to the advisability of constructing still another paralleling the first.

"It is my hope and expectation, in the meantime, that the public will understand and appreciate that the line, for which steel has now been allocated, cannot be counted on to provide unrestricted supplies of petroleum products for general civilian consumption. Its primary function, first, last, and always, must be to insure adequate petroleum supplies for our armed forces, the United Nations, war production, and the basic needs of civilian transportation and health."

Deputy Coördinator Ralph K. Davies said that it is expected that the extension will be financed in the same manner as has been the construction of the first leg between Longview and Norris City—by the Federal Government, through the Defense Plant Corporation. Work will be supervised by War Emergency Pipelines, Inc., a company organized by the oil industry to construct the Longview-Norris City leg.

Davies said that aerial surveys of the proposed route were completed last year and that ground parties already are in the field staking out the exact route to be followed. He estimated that the ground survey will be completed in 60 days from the date of announcement early this month.

When completed, the 24-in. emergency pipe-line, known familiarly throughout the oil industry as the "big inch", will be the largest ever constructed for the original purpose of transporting petroleum. Its total length will be approximately 1388 miles. Twenty-five pumping stations will force the oil from Longview, Texas, to terminals at the New York-Philadelphia refinery district.

Initial East Coast deliveries of oil via the "big inch" are expected by June 1, assuming no delay in materials deliveries, with full capacity operation beginning thereafter at the rate of 300,000 bbl. daily.

No delays are expected in establishing the route for the 24-in. line as right-of-way can be obtained, if necessary, under the terms of Cole Pipeline Act, which authorized the President of the United States to grant the right of eminent domain for projects necessary to the national defense.

Although all pipe in the Texas to Illinois leg of the line is of seamless steel construction, either seamless or electric welded pipe, or both, will be used in the extension. Adequate mill capacity is available for either type, and, according to OPC pipe-line experts, there is relatively little difference in the quality of the pipe.

◆

Construction of the Bayou Pipeline System, part of the comprehensive pipe-line program to increase oil deliveries to the East Coast, is well underway and should be completed some time in December, it was announced recently by OPC.

Deputy Petroleum Coördinator Ralph K. Davies said that the 250-mile second-hand line will have a capacity of 60,000 bbl. a day and will carry petroleum products directly from Gulf Coast refineries to the Baton Rouge end of the Plantation Pipeline.

Additional pumping stations are being installed on the Plantation line, which will increase its capacity from 60,000 to 90,000 bbl. daily. Plans also are being made to extend the northern end of the Plantation line.

Construction of the Bayou System and the northern extension of the Plantation line will (1) continue to provide the southeastern states with 60,000 bbl. of petroleum products daily; and (2) bring 30,000 bbl. daily to Richmond, Virginia, for trans-shipment by barge up the Chesapeake Bay to more northern points.

The Bayou System will consist of two segments: a 62-mile 8-in. line with a capacity of 37,000 bbl. daily from the vicinity of Baytown to Beaumont, and a 182-mile 10-in. line with a 60,000-bbl.-a-day capacity from Beaumont to Baton Rouge.

◆

Plans for laying 82 miles of pipe lines to bring additional gas from the East Texas field and increase the Lone Star Gas Company's supply to meet peak demands have been completed, with construction scheduled to begin this month, according to R. Vandercook, pipe line superintendent. Four lines will be installed by contracting companies with supervision by Lone Star personnel.

Thirty-seven miles of 18-in. pipe will begin southwest of Dallas between Lancaster and Duncanville, and continue southeast to the Dixon Farm about 9½ miles east of Alma in Ellis County. At that point it will join a 20-in. line, and parallel it for 37 miles. A 117-mile, 20-in. line will extend from Irving and tie into the East Texas gas field at Cayuga, Long Lake, and Grapeland.

Another line will begin about six miles west of Dew, and continue 31⅓ miles west to Groesbeck. It will contain 28 miles of 12-in. and 3⅓ miles of 10-in. pipe, and tie into and parallel the Long Lake-Waco 12-in. line.

Beginning 12 miles west of Dew, four miles of 8-in. pipe will be laid to Teague where it will connect with a line already in operation, adding another outlet for East Texas gas to enter the company's interconnected pipe-line system.

Another line, totaling 9.7 miles of 8-in. pipe, will be laid. It will extend from a point just north of Groesbeck, and terminate farther north, paralleling an existing line.

THE Petroleum Engineer

NOVEMBER, 1942

# Wartime Chemicals From Natural Gas[1]

**Hydrocarbons are being converted into aviation gasolines, lubricants, synthetic rubber, explosives, and many other products — Research continues**

*by Gustav Egloff*

Director of Research, Universal Oil Products Company

NATURAL gas has been used mainly for heating and generation of steam and electrical power for many years. In the last few years, however, the tempo of research and development has increased enormously. A much greater field of utilization for natural gas than as fuel is seen in the conversion of the hydrocarbons into superior aviation gasolines, lubricants, synthetic rubber, explosives, acetylene, anaesthetics, plant life promoters, plastics, solvents, and many other chemical derivatives. A vast supply of these derivatives is available in natural gas produced in this country.

The processes and methods for such conversion in some instances are already in commercial use in the petroleum refining and other industries. Other methods have been worked out in the research laboratories and the processes and yields that can be achieved are known; but it remains necessary for further research to establish the means to reduce costs to the level of commercial practicability. Another wide avenue for future development in the natural gasoline and refining industries is thus foreseen.

Natural gas is consumed at the rate of more than 2.6 trillion cu. ft. per year. The United States has proved reserves of 85 trillion cu. ft. and another 85 trillion as potential reserves. The yearly consumption of natural gas is equivalent in fuel value to 100,000,000 tons of coal or more than 500,000,000 bbl. of fuel oil.

**GUSTAV EGLOFF**

was born in New York, New York—Graduated with A.B. degree from Cornell University, 1912—Received A.M. degree from Columbia University in 1913 and Ph.D. degree from the same institution in 1916—Served with U. S. Bureau of Mines and Aetna Chemical Company in 1915 and 1916—Since 1917 he has been affiliated with the Universal Oil Products Company, Chicago, Illinois, as director of research.

In the Axis countries, methane gas is a widely used substitute motor fuel. As a matter of fact, there are more than 107,000 compressed gas (methane, ethane, propane, butanes) propelled motor vehicles operating in continental Europe, which conserved about 2,300,000 bbl. of gasoline for military use. The compressed gas is sold at filling stations in exactly the same way as gasoline in the U. S. The gases are compressed under pressures up to 5000 lb. per sq. in. into steel cylinders attached to the running board of the car or under the floor of trucks and busses. Italy has a number of natural gas wells and is operating many busses and trucks plus a number of locomotives on methane gas. This looks like a desperate measure, as it requires on the average about 135 lb. of steel for each of these high-pressure steel alloy cylinders in order to withstand the high pressures. The products of fermentation of sewage are also used as a source of methane gas in Germany. Methane from coal gas is used for running motor vehicles of one sort or another in many of the European cities. Many coal hydrogenation units produce gasoline in addition

[1]Address before American Institute of Chemists, Chemists' Club, New York City, October 23, 1942.

to methane, ethane, propane, and butanes by the Bergius and Fischer-Tropsch process. The latter process will be referred to later in more detail because it is a potential source of many products. Busses, trucks, tractors, and power shovels, totaling more than 25,000 in the U. S., use compressed propane and butane. One truck company has liquefied butane functioning in a dual role as a refrigerant for fruits and meats and as motor fuel for the truck after the cooling has taken place.

## Hydrocarbons Present in Natural Gas

Hydrocarbons present in natural gas are methane, ethane, propane, butanes, pentanes, hexanes, and heptanes, etc. The first four of these are gases and those from pentane on are liquids useful as gasoline.

The individual hydrocarbons have a variety of uses in a number of industries. Propane has been suggested for use as a fuel for breaking in aviation engines on the "testing block", as it has a high octane value and is readily available. Such a procedure would conserve the 100-octane liquid fuels needed for fighter, bombing, and cargo airplanes in the war effort. Other uses for propane that have gained wide commercial application are as refrigerants and solvents in the refining of lubricating oils. Paraffin wax, asphaltic substances, naphthenic hydrocarbons, and other materials are eliminated from lubricants when propane is used as the solvent. More than 50 percent of the world's lubricating oils are improved in quality by the use of propane.

Two hydrocarbons present in natural gas of great utility are *iso*butane and *iso*pentane. *Iso*butane is the key hydrocarbon in the production of aviation gasoline by alkylation with olefin. In general, there is not enough *iso*butane available, hence it has been necessary to isomerize the normal butane present in natural gas to the *iso* compound. A number of commercial installations are in operation and under construction to isomerize normal butane to *iso*butane. Normal and *iso*pentane are also present in natural gas, and it is highly desirable to fractionate out the *iso* compound due to its 91 octane rating in contrast to the normal, which has an octane number of 64. *Iso*pentane is blended with aviation gasoline in percentages ranging from 10 to 20, depending upon the other components in the final blend.

Olefinic hydrocarbons, not contained in natural gas as such, are important for many reactions not alone for aviation gasoline but for synthetic rubber and a host of other products. There are several routings to produce olefins from natural gas: one is high temperature, and the other by catalysis. The olefinic hydrocarbons now in great demand are ethylene, propylene, butylenes, pentylenes, and butadiene. Natural gas, particularly the propane-butane fraction, when subjected to high temperature cracking, produces ethylene, propylene, butylenes, and butadiene. Normal butane is readily converted into butadiene in one or two stages by catalytic means at high temperature with yields reported of more than 60 percent.

A branched chain paraffin, *iso*octane, is of great importance in the aviation fuel program. There are two methods whereby this hydrocarbon is derived, one is by polymerization in which *iso*butylene is polymerized to a dimer in the presence of phosphoric acid as a catalyst. *Iso*octene is the product, and upon the addition of hydrogen, *iso*octane results. *Iso*octane has an octane rating of 95-100. Another method of producing aviation gasoline is to polymerize the propylene, butylenes, and pentylenes present in cracked gases to a polymer gasoline under selective conditions, which upon hydrogenation yields an aviation gasoline blending product of 90-octane rating.

The polymerization process has been largely replaced by the alkylation process in which *iso*butane is alkylated by butylenes in the presence of sulphuric or hydrofluoric acid catalysts. The resulting alkylate ranges in octane value from 91 to 96. The simplest of the olefins is ethylene, which is used to alkylate *iso*butane at temperatures in the order of 950°F. and pressures up to 5000 lb. This reaction produces neohexane having an octane rating of 94, an important hydrocarbon for aviation gasoline. In addition to alkylating ethylene and butylenes, propylene and pentylenes are also being alkylated with *iso*butane to form additional quantities of high quality aviation gasoline. It is proposed in some type of operation to utilize the mixtures of propylene, butylenes, and pentylenes in the alkylation reaction with *iso*butane using hydrofluoric acid as alkylating catalyst to produce alkylate of 91-octane rating highly suitable for aviation gasoline blending stock.

An important aviation blending fuel of an entirely different type is cumene, which is produced from the alkylation of propylene and benzene in the presence of solid phosphoric acid. A number of commercial units are now in operation.

Normal hexane and heptane are two hydrocarbons that from a motor fuel standpoint are practically worthless unless their molecular structure is changed. Normal heptane has a zero octane rating and hexane about 23. These straight-chain paraffin hydrocarbons, hexane and heptane, can be changed in configuration and also in their properties to improve their antiknock properties. Hexane and heptane can also be converted into benzene and toluene—two important hydrocarbons for high explosives. Benzene is of vital importance in the production of styrene, which is produced by the alkylation of benzene with ethylene forming ethyl benzene. Dehydrogenation of this compound yields styrene. When styrene (25 percent) and butadiene (75 percent) are mixed in the presence of a catalyst such as peroxide, polymerization takes place to form the synthetic rubber Buna-S.

## Synthetic Rubber Program

The synthetic rubber program in the U. S. calls for 886,000 tons as planned in September, 1942, distributed as follows:

| *Types* | *Tons* |
|---|---|
| Buna-S | 705,000 |
| Butyl | 132,000 |
| Neoprene | 49,000 |

The recommendations of the Baruch Committee, however, called for an increase of 220,000 tons to be apportioned as follows:

| *Types* | *Tons* |
|---|---|
| Buna-S | 140,000 |
| Neoprene | 20,000 |
| Thiokol | 60,000 |

Of the total 886,000 tons of synthetic rubber planned for the United States, 705,000 tons will come from butadiene and styrene. The normal butane that will be used for butadiene will represent about 80,000 tons a year derived largely from natural gas. One plant has a rated capacity of 66,000 tons and the other 15,000 tons a year.

More than 100,000 bbl. a day of normal butane are available from natural gas. If this were used only for butadiene making, it would satisfy the entire butadiene requirements in our present synthetic rubber program. Hence, it can be seen that the natural gas industry has more than enough of the hydrocarbons that can be converted into raw materials to supply the entire synthetic rubber program. Another important source of butadiene is through the dehydrogenation of butylene derived from catalytic cracking. This source will yield at the rate of 283,000 tons annually.

Another type of synthetic rubber is called Thiokol, made by chlorination of ethylene, which is then refluxed with sodium polysulphide. The synthetic rubber program calls for 60,000 tons of Thiokol yearly. Hydrogen sulphide is present in varying percentages in natural gas and is readily converted into flowers of sulphur. This sulphur

may react with caustic soda to produce sodium polysulphide. After reacting ethylene with chlorine, the dichlorethane is formed, which reacts with the polysulphide yielding Thiokol. The plans call for the use of Thiokol in retreading of tires.

Besides butadiene, styrene, and ethylene, a hydrocarbon of great importance is acetylene, used in the production of the synthetic rubber, Neoprene; it is also the base material for nylon, a replacement product for silk. Calcium carbide is produced from coal and lime in electric furnaces requiring much electrical power. When water is added to this compound, acetylene is formed.

Natural gas or products therefrom under high temperature conditions yield acetylene readily. Two commercial acetylene units are being installed at the present time, one of which will produce at the rate of 75 tons per day or 27,000 tons a year. Other units are also under way. The charging stock may be either propane, butane, natural gasoline, or fractions from petroleum. It is believed that acetylene can be produced at a lower cost from processing natural gas than by the electrochemical method of producing calcium carbide. The natural gas industry has enormous volumes of propane and other hydrocarbons available to supply the entire needs of the United Nations for acetylene and its derivatives.

Germany uses acetylene made from calcium carbide converting it into butadiene by a four-stage chemical process. Neoprene rubber is made from acetylene treated with hydrochloric acid. This type of rubber will be produced at the rate of 49,000 tons a year in the United States.

The Russians start primarily with ethyl alcohol from grain to produce butadiene. Butadiene from ethyl alcohol derived from grain will be one of the sources in the U. S. synthetic rubber program. The tonnage of butadiene from grain alcohol will be at the rate of 242,000 a year, representing about one-third of the Buna-S type production.

There are several other types of rubber that are in commercial production, one of which is the type based on *iso*-butylene from dehydrogenation of *iso*-butane from natural gas or from cracking of oil. *Iso*butylene is copolymerized with about 2 percent of butadiene or *iso*prene resulting in a product called Butyl rubber. In the government program this type of rubber will be produced at the rate of 132,000 tons a year. Butyl rubber, as of today, is not as good a synthetic rubber for tire use as the Buna-S. Tires made of Butyl rubber have a mileage life of about 12,000 miles with a maximum road speed of 35 miles an hour. This will naturally be improved upon.

There is an important use for synthetic rubber that is fabricated so that billions of minute air cells are present; it is used as a liner in gasoline tanks in fighting, bombing, and pursuit planes. When a bullet goes through the tank, the rubber causes it to be self-sealing.

Another type of synthetic rubber is the acrylonitrile-butadiene, which can be produced also from natural gas and is known as Buna-N or Perbunan.

One of the necessary materials in the compounding of either natural or synthetic rubber is carbon black, which is made from natural gas. Carbon black is an important component in tires or other rubber goods whether it is blended with natural or synthetic rubber, as the properties of rubber, particularly from the standpoint of the tensile strength and wearing qualities under service conditions, are greatly improved. During the year 1940 about 369 billion cu. ft. of natural gas were converted, largely by the channel process (air oxidation), into carbon black with an average of 1.54 lb. per 1000 cu. ft. of gas or about 285,000 tons, of which about 85 percent was used in tires. Furnace black appears to be superior for use in synthetic rubber.

The world's natural rubber production for 1941 was about 1,675,000 long tons of which the U. S. imported more than 800,000 long tons. The United Nations have lost more than 95 percent of the world's natural rubber sources and Russia has lost two of its synthetic rubber plants in the Ukraine.

With the tremendous increased demand for airplanes, tanks, motor trucks, ships, trains, gun mountings, etc., rubber is required in ever-increasing quantities both by the fighting forces and the necessary civilian users for the successful conclusion of World War II. A medium size tank requires 500 lb. of rubber, small pontoon bridges 1000 lb., for flying fortresses the gasoline tank alone requires 500 lb. of bullet-sealing rubber; a large bomber uses 1250 lb., gas masks 0.75 lb., and battleships between 75,000 and 150,000 lb. Tires for large excavation trucks used by the Army have a diameter of 9.5 ft. and weigh more than 3500 lb. There are many hundred more products requiring rubber that are vital in the war effort, such as blimps, barrage balloons, rubber boats, rafts, and life vests and suits for flyers, hospital rubber needs, etc. Millions of soldiers on the fighting fronts require rubber in one form or another.

The synthetic rubber program in the U. S., with its 886,000 tons a year at plant costs of about $800,000,000, is already under way. The Baruch Committee has recommended that this tonnage be increased to 1,106,000 tons a year. In addition to being the arsenal for many other war products, synthetic rubber will also have to come from the United States to supply our allies' needs. It may well be assumed that even 1,106,000 tons of synthetic rubber will be too low for the United Nations' requirements.

The question arises now: Is the synthetic rubber product equal to the natural? In general, one can say that synthetic rubber is at least equivalent to the natural; the chemist's goal is not necessarily to synthesize a duplicate of natural rubber, but it is certain that whatever properties rubber has that are needed will not only be duplicated, but radically improved and new ones added. Synthetic rubber is superior to natural rubber in gasoline, oil, and chemical resistance. The synthetic product is more stable to light and air, and has greater wearing properties. Some trucks using synthetic rubber tires have gone more than 35,000 miles. Sidewall tire strength is greater, meaning greater safety and better road gripability. The latter property has been tested out thoroughly on wet and muddy roads. Tests on hills with different trucks have shown that the synthetic rubber-tired vehicle goes up a hill with very little side-slipping, whereas the tires of natural rubber slipped all over the road. On curves when operating the car at high speeds, the synthetic tire is safer than the natural.

With the number of research men in the field of synthetic rubber, with expenditures of millions of dollars yearly, one can feel confident that synthetic rubber tires will evolve with a life of at least 100,000 miles or, expressed another way, the tires may well outlive the motor car.

As far as the author is concerned, synthetic rubber in the United States is here to stay and will be a permanent industry during the next peace period. With the fall of Singapore our greatest source of natural rubber was cut off. Natural rubber (December, 1941) cost about 22 cents per lb. The price ranged through the years from 3.5 cents to more than $1.00 per lb. It can be stated that synthetic rubber in mass production will cost less than 15 cents a lb.

Does this mean that natural rubber will not have its uses? As far as tires are concerned, it will not have the dominating position it has held heretofore. One may be certain that as good as synthetic rubber is today, it will be far surpassed by that yet to come. The properties of the rubber desired will be under close chemical control based upon the high purity of the components started with, catalyst, and precise con-

litions to yield the finished product. Natural rubbers vary widely in properties, due to many factors. Producers of natural rubber depend upon the life cycle of the rubber tree, climatic and soil conditions, whereas the chemically produced rubber will have the exact properties for which its structure and use was designed. Natural rubber contains a number of unknown components, whereas synthetic rubber has one, two, or three components of known characteristics.

## Source of High Explosives

Natural gas is an important source of high explosives. Natural gas in some parts of the country is being cracked into hydrogen, which is combined with the nitrogen from the air, producing synthetic ammonia. The ammonia is readily oxidized with air into nitric acid. Combination of the ammonia and nitric acid produces ammonium nitrate.

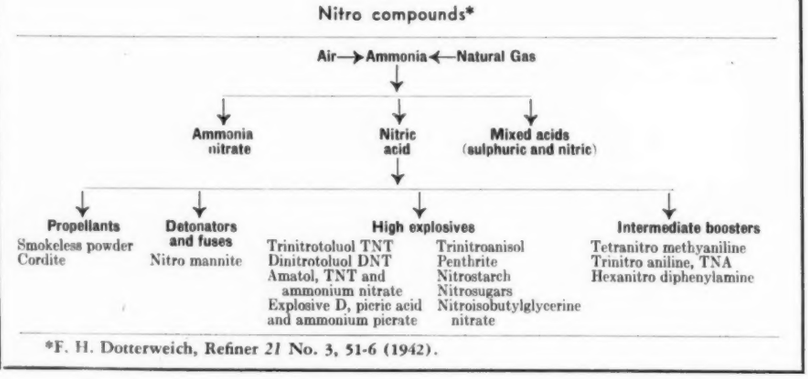
In World War I the maximum toluene production was at the rate of 15,000,000 gal. a year and practically all came from coal carbonization plants to derive coke for steel making, with toluene as a by-product. The toluene production in World War II from coal carbonization is at the rate of more than 25,000,000 gal. a year. According to published reports, the demand for toluene is from 250,000,000 to 300,000,000 gal. a year—the difference between the volume of toluene from coal and the total demand will come from petroleum, i.e., 10 to 12 times as much from petroleum. In comparing the two wars the increased demand for toluene is from 16 to 20 times. On a T. N. T. basis World War I called for 150,000,000 lb., whereas the present war calls for 3,000,000,000 lb. a year. Benzene is readily converted into carbolic acid or phenol through chlorination and hydrolysis. Combine the phenol with nitric acid and picric acid is the result, a high explosive, and when synthetic ammonia reacts with picric acid, ammonium picrate is formed, another high grade explosive. The ammonium picrate is relatively stable, but when picric acid is used, it reacts readily with iron to form iron picrate, a very unstable compound that has a habit of exploding when least expected. That is what happened in a number of plants in World War I.

Many natural gases contain hydrogen sulphide, which when oxidized with air is converted to sulphuric acid necessary in so many arts, particularly high explosives. A number of commercial units are producing sulphuric acid based on hydrogen sulphide or elemental sulphur produced from natural gas as a starting material. So we have sulphuric and nitric acid, both produced from natural gases, raw materials necessary for high explosives needed in this present war, some of which are on a scale more than 20 times that of World War I.

An important substance in war is glycerine for the production of trinitroglycerine, the commonest form of which is dynamite. The main source of glycerine has been in the splitting of fats to glycerine and fatty acids in the soap-making industry. As is well known, a campaign is on for the conservation of cooking fats of all kinds, which has been requested by our government. These fats have many uses, one of them being the manufacture of soap and glycerine. A few years ago a glycerine-making process was developed by the petroleum industry starting with propane or propylene, which are chlorinated and then hydrolized to glycerine. The glycerine is then nitrated to trinitroglycerine.

Nitroparaffins from natural gas may well develop into one of the newer and valuable sources of high explosives. Methane gas when nitrated produces tetranitromethane. This compound is the most destructive explosive known to man. This product is a very high explosive, extremely difficult to handle. About 20 years ago in a university laboratory in Switzerland, they were working with tetranitromethane, which is usually a reaction product of toluene nitration in small concentration. Ten grams of tetranitromethane killed 10 individuals, wounded 20, and nearly wrecked the building. Unfortunately, no commercial process has been worked out to make this product available for use by our armed forces. Fig. 1 shows the importance of nitro compounds in the manufacture of explosives.

FIG. 1




*F. H. Dotterweich, Refiner *21* No. 3, 51-6 (1942).

## Anaesthetics

Anaesthetics are vital in a world at war. One of the primary needs of the medical profession has been anaesthetics that do not have post-operative dangers due to pneumonia and nausea. Ethylene has been shown to have properties superior to those of ether and nitrous oxide. Deep surgical anaesthesia is readily induced by ethylene and insensibility to pain comes rather quickly. A general feeling of well being and comfort with no harmful after effects is present when ethylene is used. Cyclopropane, although known since the year 1882, was still a laboratory curiosity until the end of 1930 when it was first applied in human anaesthesia. It has been rather widely adopted since as being one of the safest anaesthetics. Cyclopropane produced from either propane or propylene by a series of chemical reactions is less explosive in the hospital than either ether or ethylene.

## For Plant Growth

Olefins have been investigated as fruit-ripening agents and for use in inducing an accelerated plant growth. The first gas to be utilized for this purpose was ethylene, which was first used in an impure form—the fumes from a kerosine stove were found to be effective in bringing about the ripening of citrus fruits. Ethylene was the agent responsible for the ripening.

Ethylene and propylene stimulate potato growth, and have been found to shorten the growth season for tomatoes, grapefruit, and oranges. The German Botanical Society reports that up to a 100 percent increase in the yield of potatoes can be obtained when the seeds are treated with ethylene gas. "The tubers of plants grown from seed potatoes which had been exposed for 24 hours to atmospheres containing 7.5, 15 or 30 percent gas at 65°F. were more numerous, larger and richer in vitamin C. It is claimed that this process is cheaper than the application of hormones."

Researches by the Russians on butylene gas showed a stimulating effect on the maturing time of such trees as the walnut, peach, apple, cherry, plum, apricot, and pear. In periods when the season is too short to allow the full maturing, due to winter weather being so prolonged that flower formation and

fruit setting are delayed, butylene may be used to hasten the growth period. The procedure adapted to plant treatment consists of enclosing the trees in tents or gastight covers for about two weeks before the normal or desired leafing, i.e., beginning of the growth cycle. Butylene is passed into the tent in about one part per 100,000 parts of air, at temperatures between 69° and 100°F. for a period of one to two hours.

Another method for ripening fruits is to use pentylenes, hexylenes, and heptylenes from cracked gasoline. Additional products of the unsaturated hydrocarbons derived from cracking, such as ethylene di-iodide, ethylene butyrohydrin, ethylene acetohydrin, and ethylene formohydrin are also used as agents for furthering the ripening of fruit.

The skin of the green fruit absorbs the olefin or olefin derivative, destroying the chlorophyll. The advantage in using liquids as ripening agents is that they are absorbed and continue their action after removing the fruit from the liquid; after storage under normal conditions, the ripening is complete.

## Plastics

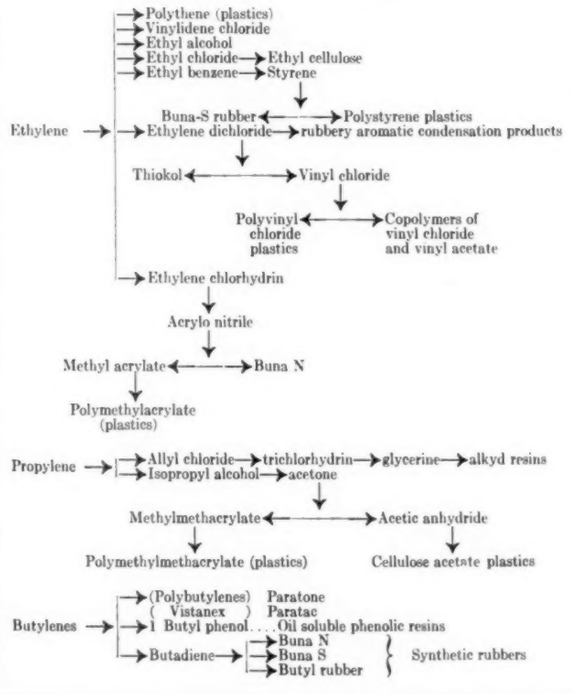
Natural gas hydrocarbons can be used as basic materials for the synthesis of plastics after forming olefinic hydrocarbons. There are three basic reactions that in various combinations are used to produce plastics from the derived hydrocarbons; they are oxidation, halogenation (mostly chlorine is used) and polymerization. Stemming from these reactions, the entire plastics industry has built up new materials and replacement products for many structural materials and rubber. Fig. 2 shows some of the derivatives of the unsaturated hydrocarbons from natural gas.[1]

The materials outlined in Fig. 2 have many uses besides plastics as the intermediates shown are a typical cross-section of the chemicals derived from natural gas. The finished plastics, as well as the intermediate compounds, find use as paints, varnishes, addition products for lubricating oils, and molded materials. Their intermediates are used as solvents, cleaning agents, and as additives for various types of products.

The coming importance of plastics cannot be over-emphasized at this time, as airplane manufacturing is calling for more of the plastics for use in plywood planes. Steel now used in many places is being replaced by plastics. In the war industries where the fabrication of planes takes place, the methylmethacrylate resins are used as the transparent non-shatterable parts when great visibility is necessary, and this will undoubtedly be used by the automobile industry after the war is over. A high degree of visibility from all over the motor car will be worked into the new design requiring less supporting framework, and a clear vision rooftop with sliding window will undoubtedly take the place of present designs. In fact, the motor car of the future may well be substantially all plastics.

[1]R. L. Wakeman, *National Petroleum News*, July 23, 1941, p. R-226.

FIG. 2




At the present time any of the components necessary for the manufacture of plastics of all types can be made from natural gas. One of the important substances for the bakelite type of plastic manufacture is formaldehyde, made largely from the methanol or wood alcohol by the catalytic reaction of carbon monoxide and hydrogen at high pressures. For a number of years formaldehyde and methanol have been produced from the oxidation by air of natural gas. This process can be readily expanded to produce all the formaldehyde necessary in the ever-expanding bakelite program. The phenol or carbolic acid and cresols, etc., are also potentially available from natural gasoline.

## Water Gas Reaction

One big field of research and development that merits discussion is carbon monoxide and hydrogen or the water gas reaction to form hydrocarbons. In the United States we have more than 2.6 trillion cu. ft. of natural gas yearly production. This gas contains about 90 percent methane, which can be converted into carbon monoxide and hydrogen by high temperatures in the presence of steam. In Germany the Fischer-Tropsch process has been developed to produce oil from carbon monoxide and hydrogen at the rate of about 15,000,000 bbl. a year. The hydrocarbons produced are methane, ethane, ethylene, propane, propylene, butanes, butylenes, gasoline, gas oil, and Diesel oil to solid paraffin wax. The reaction takes place in the presence of a catalyst, which may be oxides of nickel, chromium or cobalt, using temperatures of 400°F. and pressures of the order of 200 lb.

The gasoline produced by the water gas reaction is poor in quality with about a 40-octane rating. The gasoline has to be cracked thermally or catalytically into higher octane fuel. The gasoline fraction boiling up to 300°F. contains olefins that polymerize with each other to form lubricating oil. These lubricating oils are produced commercially in Germany and some of them are high grade. The balance of the gasoline fraction, the paraffins, hexanes, heptanes, octanes may be thermally cracked under controlled conditions to make more olefins, which in turn are converted into lubricating oil by polymerization. A portion of the synthetic oil is a high grade Diesel oil with octane number greater than 100. The Diesel oil fraction is blended with lower grade Diesel oils to improve its quality.

Paraffin wax, which is also derived from the water gas reaction, is oxidized with air to make fatty acids. The fatty acids are reacted with potassium or so-

dium hydroxide, and soap is produced. The last report out of Germany is that one small cake of soap is allotted per inhabitant per month, and much of it comes from this paraffin wax. In 1938 and previous years also, conversion of paraffin wax from the water gas reaction, coal carbonization, and petroleum, was carried out forming fatty acids. In addition, these fatty acids are combined with synthetic glycerine to make fats for food. Glycerine and soap are produced (U. S.) from the splitting of fats, but the Germans are reversing the process in order to produce edible fats for food. It is not the type of fats to which we are accustomed, but it is helpful under the critical food conditions existing in Europe.

### Research Continues

An enormous amount of research is going forward in a study of natural gas and gasoline to enhance their importance in the war effort—through solvents, plastics, high explosives, acetylene, synthetic rubber, lubricating oils, and aviation gasoline. As a matter of fact, if one starts with methane gas alone, all known synthetic products that man has produced in organic chemistry can be derived, and there are more than 500,000 different ones. Any synthetic product desired can be produced at a price; the hydrocarbons are all potentially available to be converted into the manifold products that man requires in a modern world.

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P 206.53

# Field Tests Made on Gas Condensate Wells

THE second of a series of field tests on condensate well gases to be sponsored by the High Pressure Division of the Natural Gasoline Association of America was held October 26 to 30 at the No. 1 Lulling Foundation of the Lockhart Petroleum Corporation, near Robstown, Texas.

The tests were under the general supervision of C. R. Williams, general superintendent, The Chicago Corporation, Corpus Christi. Williams is also N.G.A.A. vice-president in charge of the High Pressure Gas Division. Direct supervision at the well was in the hands of W. L. Bowser, Atlantic Refining Company, Dallas; D. A. Sillers, Lone Star Gas Company, Dallas; J. C. Birdsall, Lockhart Petroleum Corporation, Robstown; T. A. Mathews, Phillips Petroleum Company, Bartlesville, Oklahoma, and William F. Lowe, secretary-treasurer, N.G.A.A., Tulsa, Oklahoma.

Testing laboratories participating included Jarrett Laboratory, Alice, Texas; Henderson Laboratories, San Antonio; Gas Laboratories, Inc., and E. W. Saybolt and Company, Houston.

Object of the experiments, second group in a series of four at different locations and on wells of different gasoline content and pressures, was to study various accepted methods of obtaining representative samples of gases from condensate wells. Experiments were also made with a new apparatus for determining the specific gravity of two-phase gases developed by H. L. Oder and D. A. Sillers.

Others who were present for the tests included: M. M. Conn, Atlantic Refining Company, Dallas; Harry Elliot, J. S. Abercrombie Company, Houston; T. W. McGuire, Cotton Valley Operators Committee, Cotton Valley, Louisiana; Horton Pruett, Jess Scarborough, Elmer Ward, and J. T. May of The Chicago Corporation, Corpus Christi; R. F. Downey and S. M. McAnelly, Lone Star Gasoline Company, Dallas; Lester Wood, Phillips Petroleum Company, Borger, Texas; T. B. Winningham and John Dillon, Shell Oil Company, Inc., Houston; J. L. Lee, Carl Matzel, and C. Seekamp, Stanolind Oil and Gas Company, Tulsa, Oklahoma; Dr. Frank Dotterweich and Emerson Korges, Texas A. and I., Kingsville.

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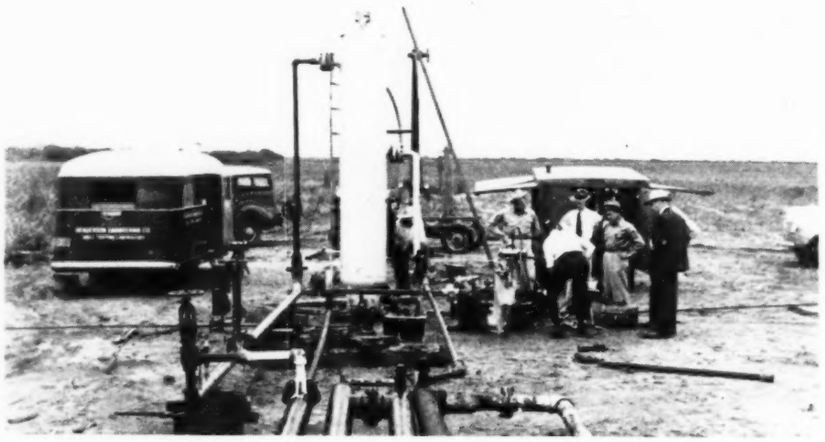


*General view of well-testing equipment showing the heat exchanger in foreground, separator in center, with wellhead and special fitting behind. The group on right is taking specific gravity tests by a new experimental method*

*Watching tests made with new experimental device for determining the specific gravity of two-phase gas.*

*Welders making the finish welds on a section of the "big inch" line extending from Texas to Illinois*

# Constructing the Large-Diameter War Emergency Pipe Line

PETROLEUM ENGINEER Exclusive Feature

**☆Crews working at top speed are finishing ahead of schedule the crude oil artery that will help relieve gasoline shortage in the East**

*by Frank H. Love*

Managing Editor

NO PIPE line in recent years has created the interest accorded construction of the War Emergency Pipelines' 24-in. crude oil artery from Texas to the East, or what has popularly come to be termed the "big inch line". Reasons for such widespread interest are apparent. It will, first of all, help to relieve an acute gasoline shortage along the eastern seaboard. From the pipeliners' viewpoint it is of more than ordinary interest because this is the first oil pipe line ever to be laid of 24-in. pipe, giving rise to a natural interest in the methods that are being employed in handling pipe of such large diameter and whether usual methods of "pipelining" can be employed. The purpose of this article is to present the construction features of this work. It might be well to mention first, however, that within recent days the War Production Board has approved extension of the line on to the East from the originally intended destination in Illinois. The total length of the line thus will be 1388 miles, terminals being in Pennsylvania and New York State. Donald M. Nelson, chairman of WPB, announced the latter part of October that the board had given approval to the recommendation of Petroleum Coordinator Harold Ickes for an 857-mile extension to the line, which has been under construction since August, and has allocated 224,000 tons of steel for the work.

Deputy Petroleum Coördinator Ralph K. Davies states that the new section of the line will be financed in the same manner as the Texas-Illinois section, by the Federal Government through the Defense Plant Corporation. Construction will be supervised by War Emergency Pipelines, Inc. Davies also stated that surveys for right-of-way are being made and should be completed by the first of the year or sooner, after which contracts for construction will be awarded.

Commenting on approval of the extension, Petroleum Coördinator Ickes said:

"The oil that this line will deliver to the refineries of the New York-Philadelphia area will benefit not only our war industries, but more important it

will make possible the release of many ocean tankships from the long haul from Gulf Coast ports. This fact alone is justification for the extension of the line."

Over the total length of the line 25 pumping stations will be installed; 11 of these are being constructed on the Texas-Illinois section. Laying of the latter section was authorized last spring. Construction work began in August and the laying of the line is expected to be completed by December 15, with crude oil being delivered by the first of the year.

Line pipe comes from the mills in 40-ft. random lengths weighing 94.62 lb. per ft. By a process of simple arithmetic this reveals that each joint of pipe weighs close to two tons. Obviously, then, the primary consideration in constructing a pipe line of such weight pipe is the need to use heavy equipment. This need applies principally to trucks and tractors. In the case of the latter the No. 8 tractor has been found most profitable to employ. When not enough of the No. 8s are available and it is necessary to employ smaller equipment counterweights have to be installed. Need for greater room in which to operate the heavy equipment has required the making of a 50-ft. right-of-way, considerably wider than the usual pipe-line right-of-way.

## Stringing Pipe

In stringing the pipe, three lengths make up the usual load. The pipe is removed from railroad cars by means of truck-mounted derricks operated by power take-offs from the trucks. These trucks are not the same ones that haul the pipe. Whenever possible the pipe is hauled directly to the pipe-line right-of-way; sometimes, however, it is necessary to truck the pipe to nearby storage lots. Selection of unloading points is made with great care, determined after inspecting the availability and condition of nearby roads and bridges. This is done by the trucking contractor in coöperation with the traffic department of the pipe-line company.

Under ordinary conditions the pipe is strung along the line as needed by the welders and unloaded by booms mounted on crawler tractors. When, due to rains, the ground is too soft for the trucks properly to place the pipe, each length has to be transported to its place in the line by a tractor, the pipe being suspended from the boom attached to the tractor. In certain swampy areas it has been necessary to build "corduroy" roads of timbers to enable tractors, stringing and ditching equipment to operate. In such instances it usually is necessary to move the pipe into the line on athy wagons drawn by tractors.

## Ditching

Minimum trench dimensions when blasting is not required are to a width of 36 in. and to a depth of 48 in. In rock where blasting is necessary the minimum dimensions are 36 in. wide by 36 in. deep. When crossing ditches, creeks, rivers, ravines, highways, railroads, other pipe lines, etc., other ditching requirements are specified, the important ones of which will be discussed later. When ditching across farm land drained by tile it is usually necessary to cut this tile; however, in all instances it is replaced. When the drainage system is an open canal the pipe line is laid 2 to 4 ft. beneath it.

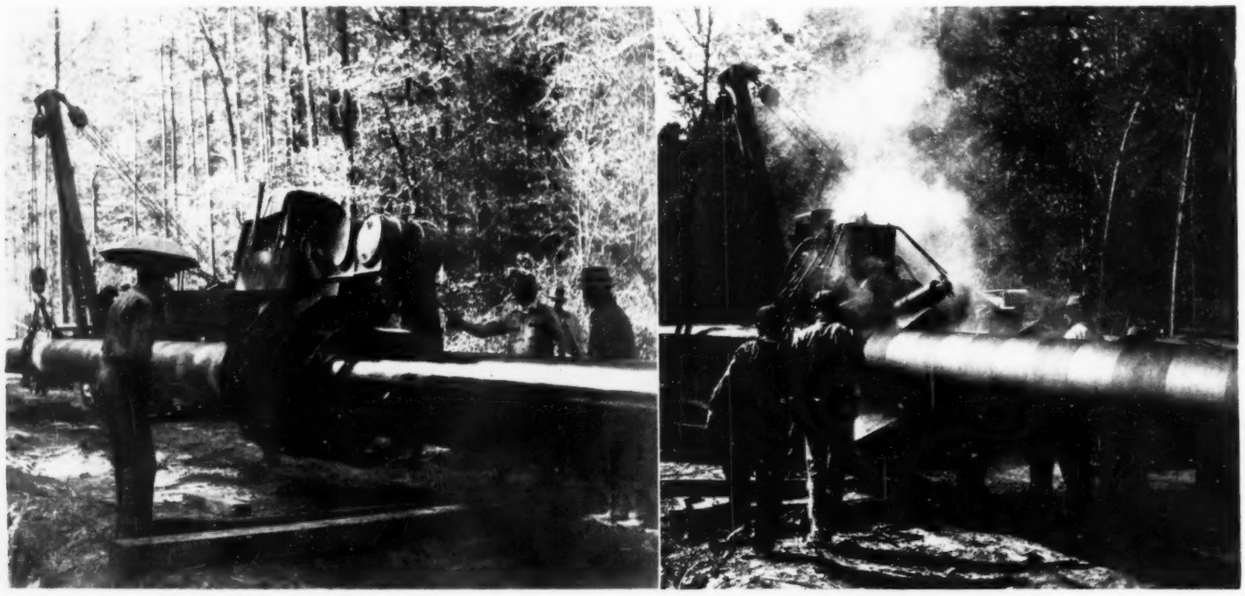
Regulation ditching machines are employed except in swampy areas inaccessible to them. Here it is necessary to dig the trench with backhoes and draglines operated from corduroy roads constructed of timbers.

## Welding

Both roll welding and stove-piping are being employed to join the sections of pipe together, the method being optional with the contractor. The greater number, however, are using the stove-pipe method. Three and four beads are being run for the most part, the shield-arc process of electric welding being used. When 400-amp. welding machines are employed and roll welds are made, three beads are run. For the first bead $\frac{3}{16}$-in. welding rod is used, for the second $\frac{1}{4}$-in. rod, and for the third bead $\frac{3}{8}$-in. rod. When making position welds (stove-piping) with the 400-amp. machine, three or more beads are used, all with $\frac{3}{16}$-in. rod. With 300-amp. machines four roll welds are made, the first bead being with $\frac{3}{16}$-in. rod, the second with $\frac{1}{4}$-in. rod, and the third and fourth with $\frac{5}{16}$-in. rod. In the case of position welds four or more beads are made, all with $\frac{3}{16}$-in. rod.

Because this is a war emergency line, and the aim is to place it in operation as speedily as possible, but with the line free of leaks, greater than normal precautions are being taken in the matter of welds. Before a welder is hired to go on the job, it is necessary for him to pass a nipple-welding test to determine his ability. In addition, inspectors for

*Cleaning the pipe and applying the primer paint (left). Applying coating and wrapper (right)*



War Emergency Pipelines, at their discretion, may require welds to be cut and tested for tensile strength. The qualifications required for welders and the standards established for welds are set forth as follows:

"Welders shall be selected for making the tacks and first bead who are able to penetrate pipe metal and build up a small amount of reinforcement at the root of the weld. No welds shall be acceptable which do not approach 100 percent penetration.The intent of these specifications is to produce welds free of porosity, gas pockets, slag pockets, or other non-metallic inclusions, pin holes, rivers, or other defects. Welds shall be rejected which, in the nick-break test, show porosity exceeding six gas pockets per sq. in. of surface exposed in the fracture and if any gas pockets exceed $\frac{1}{16}$ in. in any dimension. A minimum reinforcement of $\frac{1}{16}$ in. above the outside pipe surface will be required and this reinforcement shall be free of any appreciable concave tendency."

In the matter of testing welds, it is specified that "welds shall be cut from the line for testing as directed by War Emergency Pipelines' inspector. Twelve coupons may be cut from each test weld, four of which will be tested for tensile strength, four for ductility by the bend test, and four for porosity and penetration by the nick-break test.

"Coupons shall be tested for tensile strength using a portable testing machine. It is the intent of these specifications to produce welds which will develop the full tensile strength of the pipe metal, and the coupons shall break in the pipe metal away from the weld. If, out of the four coupons tested, more than one breaks in the weld or the juncture of the weld and parent metal, the welder will be disqualified. If only one of the four coupons breaks in the weld and such weld fails to develop the minimum tensile strength of the pipe metal, the welder will be disqualified. The reinforcement on the weld shall be left in place during the tests.

"The ductility of the weld shall be determined by the bend test. The coupons shall be ground or machined to remove the reinforcement inside and outside of the pipe so that the cross-section in the weld is the same as the pipe. Two coupons shall be bent with the bead out and two shall be bent with the bead in, placing the weld metal to be tested in tension in each case. The elongation shall be measured by pricking points $\frac{3}{16}$ in. on each side of the center of the weld and on a line at right angles to the weld. The specimen shall be bent slowly by the free bend method until the first appearance of fracturing. The distance between the prick points shall be measured after bending, using a flexible scale. The 'bead out' bend tests shall show at least 20 percent elongation (from $\frac{5}{8}$ in. to $\frac{3}{4}$ in.) of the weld metal before fracturing. The 'bead in' tests shall approach the 20 percent elongation before fracturing and shall show full penetration.

"The nick-break test shall be made in the following way. The coupons shall be weakened by nicking them at the weld with hack saw cuts and breaking them by applying tension. Each coupon shall satisfy the requirements set forth in the paragraph on weld characteristics."

*Tractors line-up an overbend for welding into the line*

Before being welded into the line, each joint of pipe is inspected and, if found to contain dirt or other obstruction inside, the pipe is swabbed. Because of size of the pipe, instead of the type swab commonly used in pipe-line work a "human swab" is employed; a workman equipped with brushes crawls through the pipe and in that manner cleans it.

After being welded, the line is left resting on skids awaiting the cleaning and coating operations.

One contractor, in stove-piping, has adopted the practice of supporting each joint on a criss-crossed structure of skids as it is tack-welded. With the pipe thus elevated at a convenient height above the ground level, the bell-hole welders are freer to work and can make greater speeds.

## Bending

Pipe bends are being made both by the hot and cold methods. Here again the practice adopted is a matter of personal choice on the part of the contractors. It has been found that even 24-in. pipe can be bent cold successfully. The two methods are similar in that in both instances a bending block is held firmly at the point where the bend is desired by a tractor equipped with a winch while another tractor with winch pulls the end of the pipe until it attains the necessary curvature. The difference is that in making the hot bend heat is applied in the customary manner at the point of the desired bend until the pipe becomes a cherry red color.

## Cleaning and Coating

After the pipe is tied-in on skids over the ditch, it is cleaned by a traveling-type, self-propelled machine equipped with a larger than usual cleaning head. A primer head attached to this equipment applies the cold primer paint to the surface of the pipe. When the primer has dried, hot enamel and asbestos felt wrapper are applied by the customary traveling-type equipment, except that an oversize coating head had to be installed to operate on 24-in. pipe. The coating is applied to a thickness of $\frac{3}{32}$ in. All voids or holidays are hand-doped.

## Lowering and Backfilling

Particular care is being given to the matter of providing the necessary amount of slack. This is obtained by laying the line alternately over and off the ditch at certain intervals, and,

when lowering the line into the ditch, a skid is left at regular intervals. Slack loops are lowered at a time of day or night when the atmospheric temperature does not exceed 80°F.

When the pipe is laid in rocky soil a cushion of earth is placed in the bottom of the trench and around the pipe to protect the coating and wrapper from damage. The backfiller is followed by a bulldozer that smooths the right-of-way and levels the soil over the pipe. On all steep slopes the ditch is riprapped before being backfilled to prevent possible washouts.

### Railroad, Highway, and River Crossings

All railroad crossings are being bored and cased, as are all hard-surfaced highways and roads except in states that have waived this requirement due to the shortage of steel. The 24-in. pipe is being placed inside 28-in. casing, the ends sealed, and proper vents provided. Casing for railroad crossings is required to be a minimum of 4 ft. 6 in. beneath the cross-ties of the track, and for highways the pipe must be at a minimum depth of 3 ft. below the low point of the roadway cross-section at the point of crossing and at such depth as not to interfere with side drainage.

Pipe used in all river crossings is given an application of cold primer paint, followed by hot enamel and asbestos felt wrapper, after which a second coating of hot enamel and a second wrapper are applied. This is a special water-works coating and is hand-applied on the job. Each welded joint is reinforced by a sleeve and 4800-lb. river clamps are spaced 30 to 34 ft. apart. Such great weight is essential as the 24-in. pipe has a buoyancy of 100 lb. per ft. and this buoyancy is increased by the wooden strips that are wired to the pipe to protect the coating and wrapper.

Most of the crossings have been made by tractors on the far bank of the river pulling the pipe into the river as each joint is welded on. The line is floated by buoys until ready to lower, when dredges suck the sand from beneath the pipe and allow it to settle to a depth of 4 to 5 ft. below the river's bed. When the river bed consists of rock, however, a different method is necessary. In such instances the pipe is covered with rock to a depth of 1 ft. and for a distance of 25 ft. on each side to catch silt and sand and thus cover the line.

The width of the Mississippi River made it necessary to lay this crossing by welding each joint into the line on the deck of a barge and floating with buoys until lowered.

Each of the river crossings is looped 250 ft. upstream to relieve strain and avoid possible breaks. All river banks are riprapped with sand bags. On each side of all rivers scraper boxes are being installed so that scrapers need not be run through these crossings and risk the possibility of having them become stuck at a place difficult of accessibility.

*One contractor found it convenient for the welders to support each joint of pipe on this kind of structure after it was tack-welded. The gentleman talking with the local lad is Ralph K. Davies, Deputy Petroleum Co-ordinator*

### Pumping Stations

The 11 pumping stations will be placed 50 miles apart, except for stations 9A and 9B, which in effect are one station divided into two sections situated 18 miles apart. This deviation was necessary because sufficient electric power was not available to operate the station as a single unit.

The prime movers in all stations will be electric motors with the power purchased. Equipment in each will consist of three 1500-hp. motors driving three single-stage centrifugal pumps having a 16-in. suction and 12-in. discharge, developing a 630-ft. head. At the tank farm at the initial station three pumping units consisting of 100-hp. motors driving single-stage centrifugal pumps will take suction from the tanks and develop an 80-ft. pressure.

Two tank farms, the location of which are not mentioned for military reasons, are being erected. One will contain fifteen 80,000-bbl. tanks and the other sixteen 80,000-bbl. tanks.

At the Illinois terminal of the section of 24-in. line now under construction, three 2000-ft. wooden loading racks having a total capacity of 900 cars daily will be provided. They will be equipped to load two grades of oil simultaneously.

The pipe line will be operated at a pressure of 700 lb. and will have a daily capacity of 300,000 bbl.

### Contractors

There are seven general contractors constructing the line, O. E. Dempsey Construction Company, Tulsa, Oklahoma; Anderson Brothers, Tulsa; Oklahoma Contracting Company, Dallas, Texas; C. S. Foreman Company, Kansas City, Missouri; Ray E. Smith Construction Company, Eldorado, Kansas; Sheehan Pipe Line Construction Co., Tulsa, and Williams Brothers, Tulsa.

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*Cables in the foreground are pulling the pipe across this river as each joint is added on the far bank. Buoys floating the line can be seen. The dredge is sucking silt and sand from beneath the pipe to bury it below the river bed*

# Drilling Fluid Technology

PETROLEUM ENGINEER Exclusive Feature

## PART 2 (Concluded)

by Lester C. Uren

Professor of Petroleum Engineering, University of California

**ABSORBING heat and lubricating the drill pipe.** Few drillers appreciate the importance of these functions of the drilling fluid because they are accomplished more or less automatically. That is, provision of a sufficient volume and quality of drilling fluid to meet other requirements will incidentally provide sufficient heat-absorption capacity and lubrication capacity to meet normal drilling requirements. Excessive bit pressure or unusually rapid advance of the drill, however, might easily create conditions that would result in serious over-heating of the drilling bit and frictional drags of the drill pipe unless compensating increase in the rate of flow of the drilling fluid is provided.

When a steel bit is revolved against a rock surface with sufficient pressure literally to tear the rock apart, a great deal of energy is expended, and necessarily heat is generated. Because of the confined space conditions and high ground temperatures that often exist at great depths, there is little opportunity for conduction of heat away from the zone of action, except through the instrumentality of the circulating fluid. Ability of the fluid to absorb heat is determined by its specific heat, by the temperature at which it is supplied and by the weight of fluid circulated per unit of time. Pure water has a higher specific heat than clay; hence we may obtain maximum cooling effect with fluids containing low percentages of clay, supplied at low initial temperature and in large volume, that is, at high flow velocity.

The circulating fluid also has the duty of reducing the frictional drag of the drill pipe on the wall of the well. Although smaller than the bore of the well, the drill pipe revolves eccentrically and is distorted by stress, so that it develops pressure contact with the walls of the well at many points. Were it not for the plastering action of the clay particles suspended in the drilling fluid and the clay sheath deposited on the walls of the well, abrasion of the drill pipe would be rapid and a great deal more power would be consumed in its rotation. Although clays cannot strictly be said to possess lubricating properties, yet because of the ease with which the clay particles shear and slide upon each other, they greatly reduce the sliding friction that would otherwise develop between the metal and rock surfaces. Some varieties of clay, such as bentonite, possess better "lubricating" properties than others. Presence of sand or gritty material in the drilling fluid, of course reduces the lubricating value.

### Physical Properties of Drilling Fluids

Among the properties of clay-laden fluids that are important in determining their performance as circulating fluids in rotary drilling, density, viscosity, colloidity, shear or gel strength, sand and salt content are important.[15,16,28,35,43,46] Density of the drilling fluid is of significance in its function of lifting drill cuttings and offsetting high formation pressures. Viscosity of the fluid influences its fluidity and the frictional resistance offered by the circulating system to flow.[41] Settling of sand and drill cuttings and release of entrained gas from the drilling fluid is also adversely influenced by high viscosity. Colloidal properties of the circulating fluid are important in determining its ability to form a mud sheath on the wall of the well, lubricate the drill pipe, prevent loss of fluid to the formation, and restrict admission of formation fluids to the well. Gelling tendencies that help to maintain drill cuttings in suspension are also an expression of colloidity. The gel strength or shear value is a measure of the resistance offered to settling of drill cuttings through the gelled fluid. Sand content is objectionable in a drilling fluid because of the tendency of the sand to scour the metal surfaces with which it comes into contact during circulation and sand also adversely influences wall-building properties. Dissolved salt may alter the colloidal properties of a drilling fluid, rendering it unsuitable for use under certain conditions.

**Density.** The density of a drilling fluid depends upon the amount and specific gravity of the suspended solids. Clay-laden fluids of density and viscosity suitable for rotary drilling purposes, range in weight from 9 to 11.5 lb. per gal. or 67 to 86 lb. per cu. ft. Equivalent specific gravities are 1.08 to 1.38. The American Petroleum Institute Committee on Standard Field Procedure for Testing Drilling Fluids recommends that mud weight be measured in a unit called "A.P.I. Density", which is defined as the pressure developed by the fluid in lb. per sq. in. per 100 ft. of depth.[3]

Mud weighing more than about 85 lb. per cu. ft. (59.7 A.P.I. density), if prepared exclusively with clay and water, is apt to be too viscous to be readily handled by the pumps and gas and sand will not readily be released. If heavier fluids are needed, resort must be had to the use of finely ground heavy minerals, such as barite, hematite, pyrite, siderite, or galena, which contribute high density without corresponding increase in viscosity. With heavy minerals used in lieu of or in addition to the clay in a drilling fluid, mixtures weighing as much as 150 lb. per cu. ft. (104 A.P.I. density) may be prepared that are not too viscous to be handled by the pumps.

Several instruments are available for determining mud density. A primitive method involves weighing a gallon of the fluid in a tared bucket with a spring balance. A more accurate device for this purpose is the "Mudwate Hydrometer". This is a weighted spindle in the form of an hydrometer that suspends a closed cup containing a standard volume of the drilling fluid. The depth to which the hydrometer sinks in water is a meas-

15. "Recent Studies in Properties of Drilling Fluids," by J. F. Dodge and A. C. Frietsche. *Oil & Gas Journal*, March 28, 1935. (Am. Inst. Mining & Met. Eng. Paper.)
16. "Drilling Mud: Its Manufacture and Testing," by P. Evans and A. Reid. *Transactions, Mining and Geological Society of India*, December, 1936, Vol. 32.
28. "Evaluation of Rotary-Drilling Muds," by P. H. Jones and E. C. Babson. *A.P.I. Drilling and Production Practice, 1935*, pp. 22-23.
35. "Principles of Drilling Mud Control," by S. J. Pirson. *Oil Weekly*, issues of February 10 and 17, 1941.
43. "Cheap Mud Work Employed in Drilling Trinidad Wells," by C. N. Smith. *Oil & Gas Journal*, May 28, 1942, p. 53.
46. "Mud Technique in Iran," by M. W. Strong. *A.I.M.E. Petroleum Development & Technology, 1939*, pp. 11-21.
41. "Drilling Mud and Full-Hole Tool Joints," by R. Silent. *A.P.I. Drilling & Production Practice, 1934*, pp. 140-148.

3. "Recommended Practice on Standard Field Procedure for Testing Drilling Fluids (tentative)." American Petroleum Institute Committee on Standard Field Procedure for Testing Drilling Fluids, A.P.I. Code No. 29.

ure of the density of the drilling fluid and is indicated directly by gradations on the stem of the instrument. A less commonly used, but convenient and entirely dependable instrument for determining mud density, is the "Baroid Mud Balance".[4]

**Viscosity.** The viscosity of a drilling fluid depends upon the amount and character of the suspended solids.[7] In general, the greater the percentage of suspended solids, the greater will be the viscosity[8]; and plastic solids like kaolin or bentonite develop higher viscosities than non-colloidal substances like silica, barite, or hematite. Addition of deflocculating agents such as tannin or sodium phosphate to a clay suspension, will often produce marked reductions in viscosity. Generally, increase in alkalinity tends to increase viscosity and increasing temperature[9] tends toward diminished viscosity. Drilling fluids that possess gelling tendencies increase their viscosity markedly after coming to rest for a time, in comparison with their viscosities while in fluid motion. Actual viscosities of drilling fluids may fluctuate over a wide range with variation in the factors mentioned, actual values ranging from but a few centipoises to more than 300 centipoises.

Several instruments are available for determining drilling fluid viscosity, some being designed primarily for laboratory use, others being appropriate for field use.[11] The most commonly used device for determining relative viscosities of drilling fluids at the well, is the Marsh Funnel. With this instrument, the time necessary, in seconds, for a standard volume of fluid to discharge through a funnel of standard proportions, is taken as a measure of its relative viscosity. A more scientific instrument, designed primarily for laboratory use—though it can be carried into the field—is the Stormer Viscosimeter.[33] With this instrument, which measures the force necessary to attain a standard rate of shear, the viscosity is indicated directly in centipoises. Other more elaborate types of torsion viscosimeters have been adapted to the determination of mud viscosities under accurately controlled laboratory conditions. The "egg-beater" type of viscosimeter, in which viscosity is measured by the electric current necessary to operate a motor revolving at constant speed, direct-connected to a spindle with fixed paddles immersed in the drilling fluid, has been used to a limited extent and is convenient either for field or laboratory use.

**Colloidal properties of drilling fluids.** Ability of a drilling fluid to form a suitable mud sheath on the wall of the well, to seal the pores of the wall rocks, and to lubricate the drill pipe, depends upon its colloidal properties.[1,30] Clay-laden fluids possess colloidal properties in varying degree, depending upon the characteristics of the clay used, but influenced also by the chemical constitution of the water phase. Bentonitic clays have colloidal properties more highly developed than most kaolinites, and specially prepared bentonitic mixtures are often added to drilling fluids deficient in colloidal values.

There is no unit of colloidity and no method of measuring the colloidal value of a drilling fluid in a strictly quantitative sense. Methods are available, however, for indicating relative colloidal values of different fluids and of predicting their probable behavior in functions where colloidity is a controlling factor. The most direct method is that afforded by a wall-building test instrument.[27] Here the ability of a fluid to form a mud cake under conditions closely simulating those at depth in an actual well, may be directly observed.[4] In such an instrument, drilling fluid is forced, under controlled pressure and temperature conditions, through a screen-supported filter on which a mud cake is formed.[29] The thickness of the cake and the rate of filtration of water through it are taken as a measure of its effectiveness. The more colloidal clays form thinner cakes and have a lower rate of filtration.[50]

**Hydrogen ionization value.** The hydrogen ionization (pH) value of a clay suspension, or degree of acidity or alkalinity, is of interest as an index of colloidal value as well as of other properties. Ability of the clay to remain in suspension in water, viscosity of the mixture, its gel strength, corrosiveness, and extent of gas absorption are drilling fluid properties that appear to be closely related to the hydrogen-ion concentration. This property may be measured in a comparative way and values expressed in terms of the pH (Sörensen) scale, by either colorimetric or electrometric methods. Both methods have been tentatively approved[3] by A.P.I. Code 29. In the colorimetric method, as exemplified by the Wulff pH Tester, strips of gelatin are impregnated with different dyes that assume either one or two colors or a blended intermediate tint when immersed in fluid of the pH value for which the dye is sensitive. The electrometric method, as exemplified by the Beckman pH Meter, involves generation of an electrical potential in a glass electrode system by the fluid under test, the potential, as measured by a sensitive milli-voltmeter, being proportional to the pH value of the fluid.

**Thixotropic properties.** The term "thixotropy" is applied to that property of a water-suspension of clay that causes it to become a semi-solid "gel" when it is left undisturbed for a time.[2] The jelly-like mass thus formed, is readily disintegrated by agitation, so that it again takes on the characteristics of a fluid.[20] The apparent viscosity of a drilling fluid may thus vary over a wide range, depending upon the extent to which the lattice-like coagulation of suspended clay particles forming the gel has advanced. A drilling fluid in rapid circulation through the well may have an apparent viscosity of only 20 centipoises. After a 10-minute period of quiescence, the same fluid may have an apparent viscosity of 1000 centipoises or more. This is a valuable property in a drilling fluid, for by means of it the suspended drill cuttings are prevented from settling in the well when circulation is interrupted. So long as the

4. "Drilling Mud Syllabus," Baroid Sales Company (Los Angeles, Calif.). *Drilling Mud*, Vol. 8, No. 1, May, 1941. 16 pages
7. "Viscosity Characteristics of Clays in Connection with Drilling Muds," by G. Broughton and R. S. Hand. *A.I.M.E. Petroleum Technology*, November, 1938, T.P. 1002.
8. "Some Factors Affecting Viscosity of Rotary Muds," by W. H. Burke. *A.I.M.E. Petroleum Development & Technology, 1935*, pp. 53-61.
9. "Effect of Temperature on Plastering Properties and Viscosity of Rotary Drilling Muds," by H. T. Byck. *A.I.M.E. Petroleum Development & Technology, 1940*, pp. 165-174. See also, *Petroleum Technology*, November, 1939.
11. "Drilling-Fluid Viscosimetry," by W. T. Caldwell, Jr. *A.P.I. Drilling and Production Practice*, 1941, pp. 104-114.
33. "A Comparison of Marsh Funnel and Stormer Viscosities of Drilling Muds," by J. E. Owen. *A.I.M.E. Petroleum Technology*, September, 1941. Tech. Paper 1373.
1. "Rotary Drilling Fluids," by H. A. Ambrose and A. G. Loomis. *Science of Petroleum*, Oxford University Press (1938), pp. 448-459.
30. "Colloidal Properties of Clay Suspensions," by W. K. Lewis, Lombard Squires, and W. I. Thompson. *A.I.M.E. Petroleum Development & Technology, 1935*, pp. 38-52.
27. "Field Control of Drilling Mud," by P. H. Jones. *A.P.I. Drilling and Production Practice, 1937*, pp. 24-29.
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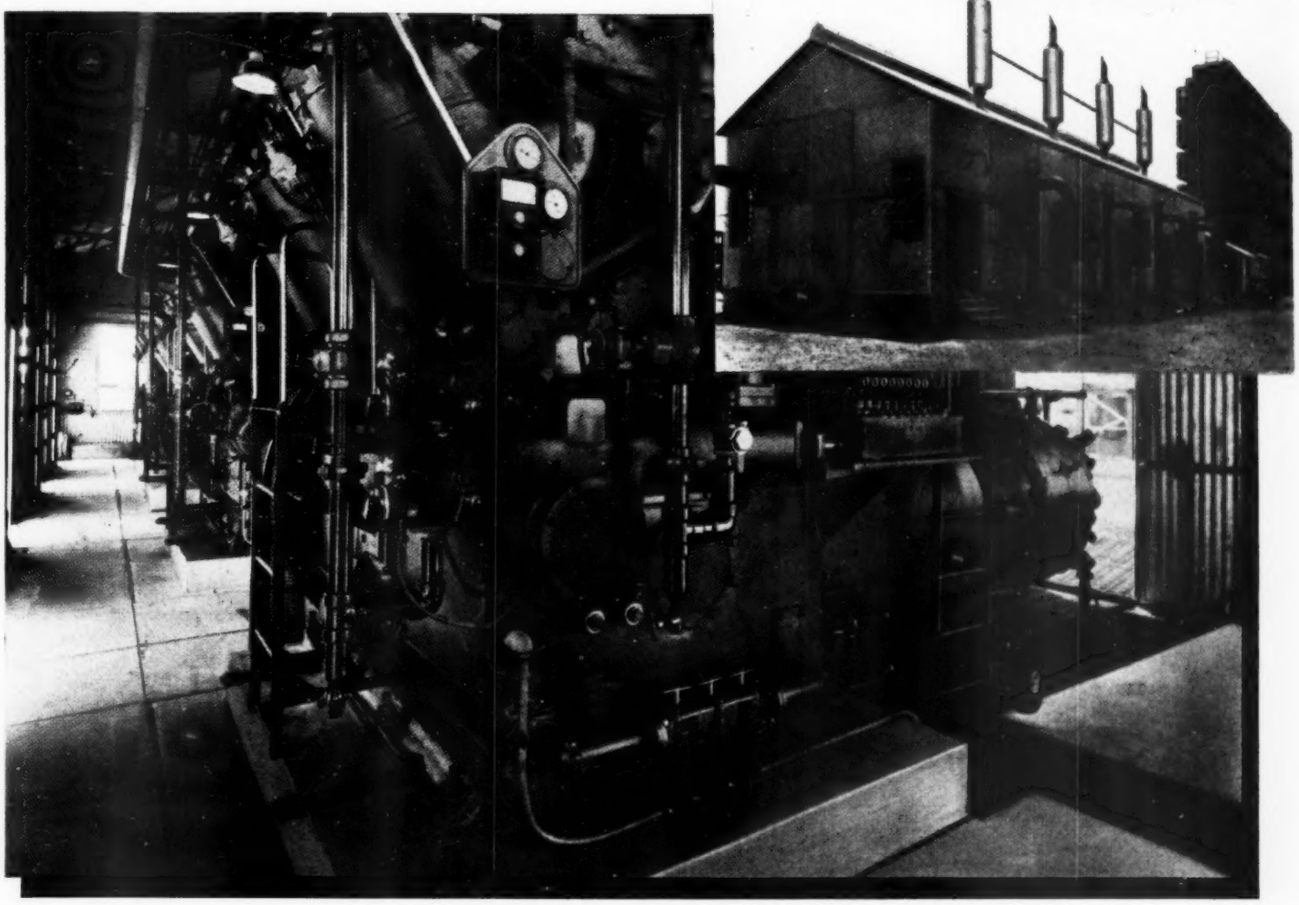
50. "Evaluation of Filtration Properties of Drilling Mud," by M. Williams and G. E. Cannon. *A.P.I. Drilling & Production Practice, 1938*, pp. 20-28. See also, *Oil Weekly*, Vol. 90, No. 2 (1938), pp. 25-32.
2. "Fluidities of Thixotropic Gels: Bentonite Suspensions," by H. A. Ambrose and A. G. Loomis. *Physics* (1933), Vol. 4, No. 8, p. 267.
20. "Dispersion of Clays and Shales by Fluid Motion," by A. D. Garrison, K. C. ten Brink, and P. B. Elkin. *A.I.M.E. Petroleum Development & Technology, 1940*, pp. 195-205. See also, *Petroleum Technology*, November, 1939.

# *Power for the Eagle With Type G-MV's!*



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fluid is in motion, the "gel strength"[38] or "shear value" remains low and the drill cuttings settle out readily in the mud ditch.[47] But if, for any reason, the pumps are stopped for a time, the fluid in the well increases its gel strength and the drill cuttings remain suspended.

Settling of drill cuttings through the drilling fluid is resisted by the gel strength or shear value of the fluid, a property that can be measured[44] in a comparative way by either of two types of instruments. The simplest of these is the Marsh Funnel, previously mentioned as a device for measuring comparative viscosity. The time of efflux of the standard volume of fluid from the funnel is first determined immediately after a period of agitation; then a second time after a 10-minute period of quiescence. The difference between the two values, expressed in seconds, is the "ten-minute Marsh gel strength".[45] The Stormer Viscosimeter, previously mentioned, may also be used in much the same way. The "Shearometer" adopted tentatively in A.P.I. Code No. 29 as a standard instrument for determining relative gel strengths of mud fluids, is simply a thin-walled metal cylinder of standard proportions and weight. The cylinder is placed in the fluid in a vertical position and the extent to which it sinks in the fluid is taken as a measure of the gel strength.

**Sand content of drilling fluids.** The sand content of drilling fluid is detrimental from every point of view. If present in sufficient amount, it may freeze the drill pipe or drilling bit to the walls of the well, perhaps causing a "twist-off". If casing is being lowered into the well through sand-laden fluid, it becomes "logy" and may not reach the intended setting depth. Sand in the drilling fluid is abrasive and may result in rapid scouring of pump liners, drill pipe, casing, and other metallic equipment with which it comes into contact. Sand-laden fluid also has poor wall-building properties, developing a thick wall cake, with consequent danger of interference with passage of tools and casing.

All material coarser than 200-mesh may be regarded as "sand" and good practice requires that the sand content of drilling fluid be maintained below 5 percent. Either of several test methods may be used to determine sand content, including elutriation, centrifuging, dilution and gravity settling, and sieve analysis. American Petroleum Institute Code 29 recommends the elutriation method and a simple type of elutriator is employed in which water flowing upward at a fixed rate removes the suspended clay and fine solid particles, leaving the sand component in the elutriation tube, which is graduated to read directly in sand volume. Other methods of determining sand content may be used if elutriation apparatus is not available. A few minutes rotation of a sample of drilling fluid in a centrifuge will concentrate all sand in the bottom of the centrifuge tube so that its volume may be estimated directly by reference to the tube graduations. Another simple method consists in placing a measured amount of drilling fluid in a graduated glass sedimentation tube, or centrifuge tube, diluting with water, agitating and then allowing the tube and sample to stand at rest for a definite time interval. The volume of sand that has settled to the bottom of the tube at the end of this time may be taken as a measure of the sand content. The sieve-analysis method of sand determination involves passing a measured volume of drilling fluid through a 200-mesh screen, washing away excess clay, gathering and weighing or determining the volume of sand so segregated.

**Salt content of drilling fluid.** Contamination of drilling fluid with salt may have serious consequences, perhaps causing flocculation of the clay particles and impairing the wall-building properties. The concentration of dissolved salt in a drilling fluid may be determined either by titration with a standardized silver nitrate solution to determine chloride content, or by measuring the electrical conductivity of the fluid.[40] An electrical apparatus is available that continuously indicates the conductivity of the fluid flowing through the mud ditch. A sudden increase in conductivity is taken as evidence of contamination of the well fluid by salt water.

**Mud-control laboratories a necessity.** Consideration of the nature of the tests employed in proper drilling-fluid control, and the character of equipment used, will suggest the need for well-equipped and conveniently situated field laboratories on properties where any considerable number of wells are to be drilled.[13] Although some of the test equipment employed is rugged enough to permit of taking it into the field, for most of the tests the facilities of a laboratory will be desirable. Personnel employed must be technically trained and skilled in the use of delicate equipment. In lieu of a field laboratory, some operators carry all necessary test equipment to the well in a small portable laboratory built into an automotive trailer, which is left at the well for use whenever circumstances require.[39]

## Drilling Fluid Constituents

In addition to clay and water, the principal constituents of nearly all drilling fluids, a variety of other materials may be used in developing certain properties. Finely ground heavy minerals may be added to confer high density; highly colloidal material may be added to increase thixotropic properties; chemical reagents may be added to control viscosity, and fibrous materials may be added to assist in sealing highly permeable formations. Rarely, oil-base fluids carrying carbon black in suspension are used in drilling in low-pressure reservoir rocks, rather than clay-laden water. The petroleum technologist should be familiar with the properties of these different constituents and with their influence on the performance of drilling fluids under different conditions.[45]

**Clays.** Clays are derived by a process of degradation and weathering from various silicate igneous and metamorphic rocks. Chemically they are composed primarily of hydrated aluminum silicates of very small particle size but they vary in the percentage of silica, alumina and combined water and various metallic oxides are usually present as impurities. They are therefore not to be regarded as minerals having a fixed composition.[26] Clays may be classified broadly into two groups:[32] (1) The Kaolinite Group having the approximate formula $A1_2O.2SiO_2.2H_2O$, and (2) The Montmorillonite Group having the

38. "Effect of Temperature on the Gel-Strength of Some Gulf Coast Drilling Muds," by B. I. Routh and B. C. Craft. *A.I.M.E. Petroleum Technology*, August, 1938, Tech. Paper 961.

47. "Cuttings in Rotary Mud," by P. D. Torrey. *International Oil*, January, 1942, pp. 15-18.

44. "The Eykometer: a New Device for Measurement of the Yield Point of Clay Suspensions and Oil-Well Drilling Muds," by A. G. Stern. *U. S. Bureau of Mines R. I. 3495*, February, 1940, 21 pp.

45. "Role of Clay and Other Minerals in Oil-Well Drilling Fluids," by A. G. Stern. *U. S. Bureau of Mines R. I. 3556*, February, 1941, 88 pp.

40. "Factors Influencing Electrical Resistivity of Drilling Fluids," by J. E. Sherborne and W. M. Newton. *A.I.M.E. Petroleum Development & Technology, 1942*, pp. 204-220.

13. "Control of Drilling Mud in the Field," by H. C. H. Darley. *Journal, Inst. of Petroleum*, October, 1940, pp. 457-474.

39. "Refined Testing Methods at Well Improve Mud Control," by W. A. Sawdon. *The Petroleum Engineer*, September, 1938, pp. 80-82.

26. "The Mineralogical Constitution of Clays," by G. D. Hobson. *Science of Petroleum, 1934*, Oxford University Press, pp. 460-462.

32. "Colloid Chemistry of Clay Drilling Fluids," by A. G. Loomis, T. E. Ford, and J. F. Fidiam. *A.I.M.E. Petroleum Development & Technology, 1941*, pp. 86-99. See also, *Petroleum Technology*, May, 1940. See also, *International Oil*, July, 1941, pp. 40-46, under title "Control of Clay Drilling Fluids."

approximate formula $Al_2O_3.4SiO_2.H_2O$. When hydrated, clay particles are believed to arrange themselves in a laminar crystalline lattice in which alternate layers of aluminum and silicon atoms are bound together by oxygen bridges. Though very thin, the individual clay particles have great strength, forming rigid, plate-like particles with a very large ratio of length to thickness.[31] When dry, the individual clay particles are bound closely together, but when hydrated the water molecules migrate in between adjacent clay laminae and force them farther apart so that the mixture assumes plasticity.[32] When still further dispersed in water suspension, the individual clay particles display Brownian movement, but if the fluid gels, this motion ceases. The extent to which a clay expands or is dispersed on hydration, depends upon its origin and upon the chemical and colloidal nature of other substances present. In nature, clays are always associated with various adsorbed cations, usually alkaline or alkaline earth cations that are readily replaceable by each other or by hydrogen; and these adsorbed substances have much to do with the properties and behavior of the clay.[18]

Kaolin, the most common variety of clay, contains a large percentage of inert material and colloidal properties are not usually well developed, though all clays contain more or less colloidal material. In a drilling fluid, kaolin is useful primarily in conferring weight and viscosity. The kaolin particles are comparatively coarse, upward of 90 percent of the particles being of such size that they can readily be seen by the ordinary microscope.

Bentonite, one of the best known members of the Montmorillonite group, has well-developed thixotropic properties.[14] It is supposed to be an end product of the weathering of volcanic ash. The particle size is unusually small, being scarcely visible under the more powerful microscopes. These minute colloidal particles absorb water rapidly, seemingly expanding to many times their size when dry. Though present in small amount, they are readily dispersible in water and yet may gel to form a cellular network that enmeshes relatively large amounts of water and gives some degree of rigidity to the fluid.[37] When not gelled, they display a remarkable mobility and carry strong negative electric charges on their relatively large surfaces: properties that enable them to remain afloat in water with little tendency to settle out or to flocculate. Bentonite particles have highly developed the property of adsorbing water and ions of various substances with which they come into contact. They display the property of swelling on absorption of water in varying degrees, and the extent of expansion on hydration is regarded as an index of the value of the material for drilling purposes. A good bentonite will expand to form 20 to 40 times its dry volume on slow hydration.

Kaolinite clays are plentiful in nature; bentonitic clay less so. When the clay used in a drilling operation is deficient in colloidal material and lacks thixotropic properties, controlled amounts of finely ground bentonite may be added to the drilling fluid to improve its quality.

**Water.** The water used in preparing drilling fluid should be reasonably free of dissolved salts, otherwise the properties of the clay suspension may be altered. High chloride content, which would be characteristic of sea water and might result from contamination with ground waters or by penetrating soluble salt masses in the course of drilling, is particularly detrimental. Chlorides tend to flocculate the dispersed clay particles and may destroy the colloidal properties that are so essential in wall-building and in sealing permeable formations. Occasionally soluble salts in the clay used will enter into solution in the drilling fluid and influence colloidal properties. Alkaline salts are generally not objectionable in this connection.

**Weighting materials.** Heavy minerals are frequently added to drilling fluids to increase their density, thus rendering them better able to offset high gas, oil, or water pressure. For this purpose, barite is widely used and iron oxide, galena, and various other materials are also occasionally employed. Such materials must be finely ground, it being usual to pulverize them so that 90 percent or more will pass a 200-mesh screen and a large percentage will pass a 300-mesh screen. The use of high-density minerals in drilling fluids is a patented process controlled by the National Lead Company. (U. S. Patents 1,575,944-5, March, 1926.)

Barite (barium sulphate) has a density of 4.2 and by adding it in a finely ground condition to water, a fluid having an apparent specific gravity of as much as 2.4 may be produced (150 lb. per cu. ft.). Yet such a fluid may not have excessive viscosity and is readily pumpable. A small amount of colloidal material must be added to keep the solids in suspension.

Iron oxide (hematite) has also been used extensively as a weighting material. Though of higher density than barite (5.2), it is otherwise less desirable. Other iron minerals of lesser gravity, such as limonite or siderite have also been used, as well as iron oxide prepared by roasting pyrite. Field workers prefer barite to iron oxide because reddish brown stains left on hands and clothing are difficult to remove.

Finely divided silica silt produced from natural deposits in some localities, has a specific gravity of 2.6 and though considerably less dense than barite or iron oxide, it may be added to a thin clay suspension in quantities sufficient to increase the fluid density to as much as 1.7 (105 lb. per cu. ft.) without exceeding the allowable viscosity. Drilling fluid containing silica silt has less satisfactory wall-building properties and pore-sealing ability than fluid containing barite, but in localities where it is produced it is less expensive.

Lead sulphide (galena) has a specific gravity in excess of 7 and when finely ground, may be added to clay suspensions to produce pumpable fluids weighing as much as 150 lb. per cu. ft. (sp. gr. 2.4). The material is too expensive for general use, but it has been suggested that moderate amounts might be employed in conjunction with barite or hematite and clay to produce fluids somewhat heavier than would otherwise be possible.[23] Sulphide minerals produce drilling fluids that are readily gas-cut, an important deterrent to their practical use.

**Chemical reagents employed in control of viscosity and colloidal properties of drilling fluids.** Various chemical reagents are found to be effective in altering the physical properties of clay suspensions in water and have been widely used in the control of drilling fluid viscosity.[19] Deflocculating or dispersing agents, such as tannins and certain phosphates (particularly sodium pyro-, meta- and tetra-phosphates), are

31. "Structure of Clay Gels," by W. K. Lewis, Lombard Squires, and W. I. Thompson. *A.I.M.E. Petroleum Development & Technology, 1936*, pp. 71-80.

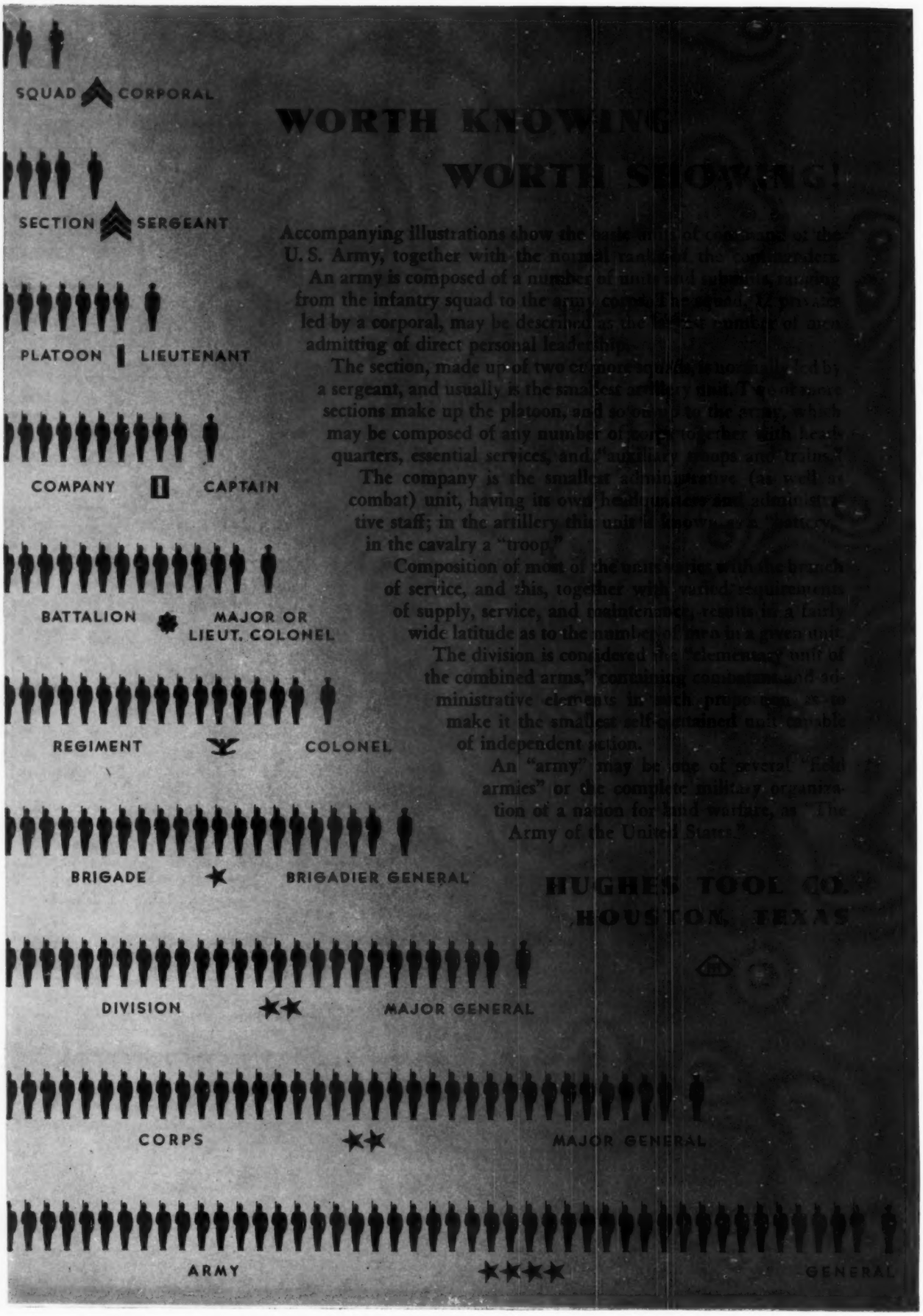
18. "Surface Chemistry of Clays and Shales," by A. D. Garrison. *A.I.M.E. Petroleum Development & Technology, 1939*, pp. 191-204.

14. "Bentonite: Its Properties, Mining, Preparation and Utilization, by C. W. Davis and H. C. Vacher (Revised by J. E. Conley). *U. S. Bureau of Mines Tech. Paper 438*, June, 1940.

37. "Recent Advances in Knowledge of the Colloidal Properties of Clay Suspensions and Gels," by C. E. Reed. *A.I.M.E. Petroleum Development & Technology, 1938*, pp. 240-262. See also, *Petroleum Technology*, February, 1938.

23. "Intensive Weighting of Petroleum Drilling Muds with Galena," by H. E. Gross. *A.I.M.E. Petroleum Development & Technology, 1938*, pp. 263-273.

19. "A Study of Some Phases of Chemical Control in Clay Suspensions," by A. D. Garrison and K. C. ten Brink. *A.I.M.E. Petroleum Development & Technology, 1940*, pp. 175-194. See also, *Petroleum Technology*, November, 1939.




## WORTH KNOWING

## WORTH SHOWING!

Accompanying illustrations show the basic units of command of the U. S. Army, together with the normal ranks of the commanders.

An army is composed of a number of units and subunits, ranging from the infantry squad to the army corps. The squad, 12 privates led by a corporal, may be described as the smallest number of men admitting of direct personal leadership.

The section, made up of two or more squads, is normally led by a sergeant, and usually is the smallest artillery unit. Two or more sections make up the platoon, and so on up to the army, which may be composed of any number of corps together with headquarters, essential services, and "auxiliary troops and trains."

The company is the smallest administrative (as well as combat) unit, having its own headquarters and administrative staff; in the artillery this unit is known as a "battery," in the cavalry a "troop."

Composition of most of the units varies with the branch of service, and this, together with varied requirements of supply, service, and maintenance, results in a fairly wide latitude as to the number of men in a given unit.

The division is considered the "elementary unit of the combined arms," containing combatant and administrative elements in such proportion as to make it the smallest self-contained unit capable of independent action.

An "army" may be one of several "field armies" or the complete military organization of a nation for land warfare, as "The Army of the United States."

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used to reduce the viscosity of drilling fluids that are too heavily loaded with colloidal material. Other phosphates have the reverse effect, tending to flocculate clay suspensions and increase drilling fluid viscosity. Various forms of tannin or gallic acid, neutralized with caustic soda (sodium tannate), have been widely employed in treatment of drilling fluids to reduce viscosity. "Quebracho" and other tree-bark extracts that are common sources of tannin are effective mud thinners and are available at reasonable cost. The viscosity of drilling fluid may be increased greatly by the addition of hydrated lime $Ca(OH)_2$. Mud treated with this material is sometimes used in drilling the first few hundred feet of a well when the hydrostatic head of fluid is insufficient to form a proper filter cake on the wall of the well.

Sodium carbonate is sometimes added to drilling fluid to increase its alkalinity. Under some conditions, it may increase the fluid viscosity. Sodium bicarbonate is sometimes used to flocculate and restore the colloidal properties of drilling fluid that has become contaminated with cement. Sodium silicate is ordinarily a flocculating agent, but in small concentrations often has the reverse effect. It also contributes alkaline properties necessary in adjusting pH values. In highly saline clay-water suspensions, sodium silicate provides a degree of protection against flocculation of clay that is helpful in drilling through heaving shales.[5] Ground barite suspended in a strong magnesium chloride brine also forms a low viscosity heavy fluid useful in drilling in heaving shales.

Finely ground limestone or dolomite are occasionally added to drilling fluids when it is intended subsequently to treat the well with acid to remove the mud sheath.[6] The acid attacks the limestone, thus disintegrating the deposited clay. This method is particularly helpful in developing production from low-pressure reservoir rocks.

**Formation sealing materials.** "Thief" formations that are responsible for excessive fluid loss in a drilling operation, perhaps even to the extent of making circulation of drill cuttings to the surface difficult or impossible, may be sealed by addition of various fibrous or flaky materials to the drilling fluid. For this purpose, straw, beet pulp refuse from sugar extraction plants and cotton-seed hulls have been used. Specially prepared fibrous materials containing asbestos fibers or mica are available on the market. Bentonite added to neat cement is also helpful in difficult cases of lost circulation.

**Oil-base drilling fluids.** In drilling through low-pressure reservoir rocks where the mud sheath formed on the wall of the well would not readily be displaced by subsequent flow of gas and oil, or where perforations in liners might become clogged with clay or production impaired by getting the walls of the well wet with water, some operators use an oil-base drilling fluid instead of a water-suspension of clay. Oil-base muds are also helpful in drilling through materials such as heaving shale, salt, etc., where the presence of water would be undesirable, and for taking cores under circumstances where contamination with drilling water would be undesirable.

Crude petroleum, Diesel oil, or stove distillate may be used as the liquid medium in oil-base drilling fluids, lamp-black is added to give gel strength and wall-building properties, and finely ground oyster shells, limestone, or barite may be used to increase density. Blown asphalt may also be added to confer plastering properties. Fluids whose density is as great as 95 lb. or more per cu. ft. may be developed by this means and the viscosity may be varied over a wide range.[24]

Oil-base muds are inflammable and when in use, precautions should be taken to minimize the fire hazard. They have little tendency to gas-cut and hence fluids of high viscosity may be used when drilling in gas-bearing formations. Although the cost of oil-base muds is materially higher than that of water-base fluids, avoidance of waste may reduce the cost to reasonable levels. After use in drilling one well, the fluid may be stored for use in another. Liners with small clearance may be set when oil-base drilling fluid is used because a very thin filter cake is deposited on the wall of the well and it has exceptionally good lubricating qualities.

## Possibilities for Additional Research

Though much competent research has been under way during recent years on different aspects of drilling fluid technology, there are still many phases of this subject that offer promise of interesting and profitable results for future investigative work. Little has been done as yet, in exploring the factors that control the efficiency of drilling fluid in its function of lifting drill cuttings.[34] There would be fewer cases of "frozen" drill pipe if we had a better understanding of the conditions that influence the lifting capacity of the circulating fluid. There is little information on bottom-hole temperatures in drilling wells and the influence of rate of circulation and mud properties on control of such temperatures.[38] More should be learned of the drilling fluid properties that promote "gas cutting", and better methods of separating entrained gas from gas-cut muds should be devised. There is opportunity for a broad study of oil-base muds, of methods of developing desirable properties in drilling fluids of this type and of controlling these properties to meet changing conditions. The properties of oil-water-clay mixtures is an almost virgin field.

Better methods of quickly evaluating clays for use in drilling fluids should be devised.[17] Is the rate of hydration a significant index in this connection? How may one determine the active colloidal content of a clay or drilling fluid? Of what significance is the size-distribution of clay particles, and can some simple test for determining this be devised?[21] There is much to be learned in the realm of chemical control of drilling fluid properties. Certain types of gums and resins produce interesting effects. More positive ways of dealing with saline-water contamination of drilling fluids must be developed.[12, 22] Methods of adapting the qualities of the mud to the peculiarities of the formation in which the drill is working—in "heaving shale", for example[36] — pre-

5. "The Chemical Control of Heaving Shale," by C. L. Baker and A. D. Garrison. *Transactions, Am. Inst. Chemical Eng.*, Vol. 34, No. 6, Dec., 1938. See also, *The Petroleum Engineer*, issues of January and February, 1939.

6. "Use of Pulverized Limestone as Rotary-Drilling Mud," by J. E. Brantly and E. H. Clayton. *A.P.I. Drilling and Production Practice, 1938*, pp. 29-33.

24. "Characteristics and Application of an Oil-Base Mud," by H. W. Hindry. *A.I.M.E. Petroleum Development & Technology, 1941*, pp. 70-75. See also, *Petroleum Technology*, May, 1941.

34. "Mud Flow in Drilling," by R. J. S. Pigott. *A.P.I. Drilling and Production Practice*, 1941, pp. 91-103. See also, *Oil & Gas Journal*, May 22, 1941, p. 62.

17. "Staining of Clay Minerals as a Rapid Means of Identification in Natural and Beneficiated Products," by G. T. Faust. *U. S. Bureau of Mines, R. I. 3522*, 21 pp. July, 1940.

21. "Measuring Particle-Size Distribution and Colloid Content of Oil-Well Drilling Fluids," by G. L. Gates. *U. S. Bureau of Mines, R. I. 3549*, 21 pp., March, 1941.

12. "High-Pressure Salt-Water Flow Need No Longer Spell Defeat in Drilling Operations," by M. L. Cashion. *The Petroleum Engineer*, August, 1940, pp. 90-97.

22. "Control of Filtration Characteristics of Salt-Water Muds," by G. R. Gray, J. L. Foster, and T. S. Chapman. *A.I.M.E. Petroleum Development & Technology, 1942*, pp. 117-125. See also, *Petroleum Technology*, September, 1941.

36. "Chemical Treatment of Bentonitic Suspensions and the Relationship to the Heaving Shale Problem," by H. H. Power and C. R. Houssiere, Jr. *A.I.M.E. Petroleum Technology*, November, 1941, T. P. 1401.

sent definite possibilities. Successful methods of selectively removing clay sheaths from oil-wet and water-wet formations would be of great value.

There is need for standardization of drilling fluid tests and test instruments. Important progress has been made toward this end by the American Petroleum Institute Committee on Standard Field Procedure for Testing Drilling Fluids,[3] but agreement has not yet been reached on all tests that are really significant or necessary, and standardization of instruments and procedures in using them is as yet only in the "tentative" stage. Colloidity is an important property in a drilling fluid, yet we have no unit of colloidity, nor is there general acceptance of any quantitative method whereby it may be measured or expressed. Lastly, it is perhaps not too much to expect that the industry might eventually evolve a standardized clay or solid component of drilling fluid: a carefully balanced, scientifically blended material that will always produce a fluid of uniform characteristics when mixed with water in proper proportions. Addition of weighting agents or chemical treatment of such a standardized drilling fluid to produce desired variations in properties might then be reduced to formula. No two clays found in nature are exactly alike in chemical and physical properties, and the present method of using any or all clays indiscriminately makes impossible a uniform system of conditioning fluids to produce desired results.

☆ ☆ ☆

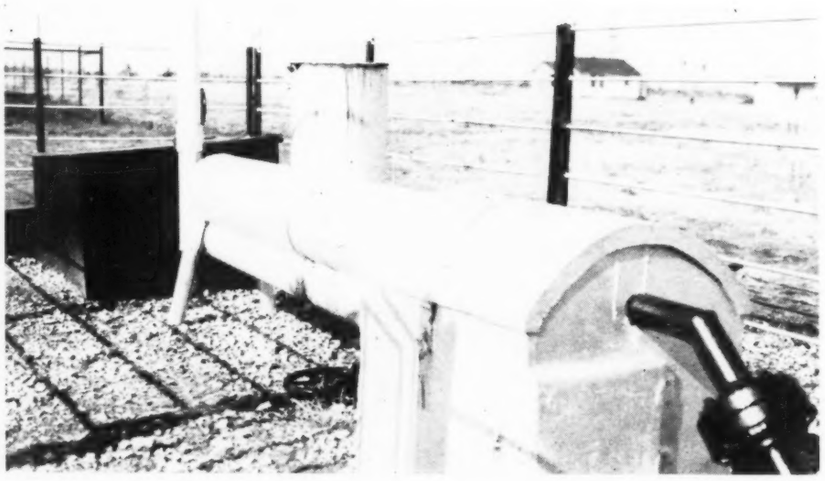
P 629.2

# Portable Heater for Preventing Hydrate Formation

*by J. C. Albright*

THE elimination of aqueous solutions from a high-pressure gas stream by means of drips installed in the line upstream from measuring, together with pressure reducing instruments, serve in many areas to prevent plugging of orifices and chokes by hydrates. In other areas heat must be used to raise the gas temperature above the point of hydrate formation. Many different types of heaters are employed, most of which burn gas as fuel with a direct transfer of heat through the walls of the transmission piping. Others use a surrounding reservoir of water to prevent excessive temperature transfer and deterioration and corrosion of pipe lines.

An installation that has proved effective for heating a gas stream, and that is so constructed that it can be moved complete from one location to another as occasion demands, is used in a Mid-Continent field in conjunction with a gas-lift project. This heater resembles a small oilfield-type boiler, with a water reservoir in the shape of a steam dome situated midway of the horizontal section, a combustion gas stack, and a firebox. The waist of the heater is made of a section of 20-in. pipe through which the gas transmission line passes from end to end. Below this section of pipe, a smaller joint is attached to carry away the products of combustion, which are vented through a vertical stack equipped with a draft vane at the upper end. The stack is in two sections, the lower of which is connected to the combustion chamber by a short nipple. The top section of the stack is connected to the lower section by a threaded coupling and may be disconnected when transporting the heater.



*This heater installed on a transmission line raises temperature of gas sufficiently to prevent formation of hydrates*

The firebox is made of sheet steel welded to the unit and is so designed that approximately 2 ft. of the 20-in. pipe is exposed directly to the flame of the burning gas. Access to the combustion space is provided by a concave lid, hinged on one side and equipped with a hasp and staple on the other for locking if necessary. The burners in the base of the combustion space may be any type that will provide a flame of the required intensity.

The gas transmission piping is equipped with bolted flanges on each end for ease when dismounting or hooking up to the line at the location. The dome is covered with a flat sheet of steel equipped with a hinge, so that dirt and debris will be prevented from blowing into the water. It is sufficiently high that the supply of water contained in the unit eliminates frequent refilling.

☆ ☆ ☆

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*Turner Valley lies parallel to and about 30 miles east of the Rocky Mountain divide. The front range is here seen across the north end of the field*

# Petroleum Development in Canada

PETROLEUM ENGINEER EXCLUSIVE Feature

*PART 2 (Concluded)*

*by Floyd K. Beach*

## Tar Sands

FAR to the north, tar sands exposed at the surface give visual evidence of hydrocarbon deposits.

Extending from end of steel at Waterways, about 300 miles northeast of Edmonton, for about 65 miles northward along Athabaska River, and for perhaps 40 miles southwest, bituminous sands are exposed by erosion of the river. In places cliffs of rich sand are to be seen rising fully 200 ft. above the middle Devonian limestones that gently rise above water level and then dip below. The tar sands are believed to be of Cretaceous age and their cross-bedded nature suggests that they are deltaic or estuarine deposits. Impregnation of bitumen is by no means uniform and ranges from solidly impregnated beds to marginal deposits where oil-rich sand a few inches thick occurs with intervals of several feet of deposits barren of hydrocarbons. Careful surface surveys with occasional shafts or borings have led the engineers who investigated the deposits to believe that the reserves of oil in this area are greater than all other combined reserves on the continent and perhaps in the world.

Efforts to make economic use of these reserves have been carried on over a considerable period of time. Mackenzie, who discovered the river that bears his name, reported the deposits a century and a half ago. Construction of a railway line, which was begun about 1910, gave various persons hope that they might cash-in on the deposits, and various experimental work was done privately. Systematic surveys covering occurrence began about 1914 and a report by S. C. Ells of investigations to 1924 was published in 1926. Experimental work on separation of bitumen from the sand was conducted at the University of Alberta, and later Dr. K. A. Clark, who had supervised the work at the University, set up a pilot plant at Waterways and demonstrated the process on a semi-commercial scale. It was only in 1941 that operations attained such proportions that they could be called commercial. Abasand Oils separated about 20,000 bbl. last year and converted it to products ranging from gasoline to fuel oil. A fire at the close of the 1941 season destroyed part of the plant and between difficulties in obtaining steel products and efficient labor, the plant was out of operation until early in August, but it has been in continuous service since then.

## Commercial Production

The problems of commercial production involve:

1. Mining the sand.
2. Conveying the sand to a separation plant.
3. Separating the oil from the sand.
4. Refining.
5. Transportation.

Mining difficulties appear to be solved. Steam jets make holes back of the face and after jetting a series of holes, explosives shatter a large mass of the sand sufficiently for a power shovel to dig it.

Tractor-driven carryalls and a conveyor belt handle the material from the power shovel to a storage platform and thence to separation vats.

Separation by hot water removes most of the sand, and dilution with light oil at this point assists in dropping out remaining inert materials. Max W. Ball, head of Abasand, asserts that a pass through a pipe still and soaking chamber at a temperature relatively low compared with ordinary cracking will bring the gravity up from 10° to 20° or 22° A.P.I. without evolution of gas or coke and with a corresponding drop in viscosity.

Energetic research into refining problems is now being conducted, and it would appear that the presence of about 5 percent sulphur is one of the matters to call for considerable attention. This sulphur is not in a corrosive form and some observers hope that it will not prove a serious matter.

## Transportation

Transportation is normally one of the principal items in the cost to consumers of all petroleum used. When the outlet for tar sand products is north-

# A BUSINESS BUILT ON SERVICE

## *to our industry . . . for our country*

Our story reflects, especially in times like these, what a group of people with a sincere desire and purpose can accomplish in Free America.

Our purpose in business was to offer to the trade the best products and service we could give. We must have succeeded, at least in the eyes of our own industry, since continued and increased patronage enabled us in twelve years to grow from one small field shop to six major manufacturing and service plants . . . from one truck to a fleet of more than 60 modern service trucks and field cars . . . from four employees to a staff of nearly three hundred.

We are still a "small" organization to the extent that each product manufactured is a personal matter with us . . . to be sure it gives the service claimed for it.

When war made it necessary for industry to lay aside private business, our modern machines and skilled personnel accumulated through increased private business immediately were able to take on their new job.

That's where our story ends today. We are doing war work first. From here on not only our story, but the story of our country depends on Industry and men doing their best with the implements and advantages Free America has given them.

HUNT TOOL COMPANY

ward from the plant, railway tariff operates as a protection against competition from oil produced naturally from wells. The same tariff operates against shipment southward, but we may forecast that when demand is adequate to support a pipe line, supplies will move southward. This is of course supposing that kinks are by that time sufficiently removed from production of gasoline and other products that can be piped.

Use of bitumen for paving should also be kept in mind. The natural sands could be used, but cost of shipping sand would be prohibitive. Trials at shipping the sand in freight cars indicate that a mining operation is almost necessary to get it loose.

It is therefore apparent that only separated bitumen can be considered for most commercial paving. The separated bitumen is very high in asphaltic content and Abasand is now conducting a series of experimental runs to establish maximum yields of asphalt suitable for paving and other uses.

The Dominion Government through the Consolidated Mining and Smelting Company is now conducting investigations regarding the advisability of a much larger operation.

## Prospecting in Alberta

A variety of geophysical methods have been used in search for favorable structures in Alberta and some companies have even drilled shallow holes in an effort to find evidence of structure. Most of Alberta is covered by a mantle of glacial drift that conceals bedrock except where streams have eroded it. Shallow test holes penetrating the drift have been drilled into bedrock to some marker. Some operators have tried to correlate markers in continental beds, and have even drilled deep tests based on conclusions derived from such testing. It must be concluded that structure test holes should be carried to a marker in marine beds to be of much value owing to rapid lateral changes in beds of continental deposition.

The magnetometer has not proved of value. There is a tendency for it to agree with topography, particularly when lakes and sloughs are present.

Some form of gravity meter may prove of value in Alberta and some such work is now in progress, but it is too early either to praise or to condemn it.

The seismograph has had considerable trial. Not all the results of such work have been made public. It would appear, however, that glacial drift has made interpretation of seismic waves difficult. The varying thickness of glacial drift has made it difficult to determine the effect of weathering in certain areas. In the disturbed belt, where beds are inclined, seismograph interpretation is much more difficult than in relatively undisturbed areas.

Discoveries of oil in the plains area have so far been principally in Mesozoic beds, the result of wildcat tests guided with respect to general area by surface geological studies. The producing areas, however, depend on local conditions in continental beds lacking structure as we ordinarily understand it, and with little if any surface indication regarding where they may be expected. The Paleozoic beds underlying the Mesozoic, but with a very considerable disconformity between them, seem to offer the best hope for the future in the plains area. A number of tests in the last year or two have penetrated the Paleozoic. When means have been found for discovering structure in these deeply buried beds we may expect progress. Possibly seismic work already done has anticipated these remarks, but if so the answer has not been in any sharp rise in oil production.

Alberta's greatest success so far has been in the disturbed belt and we rather naturally look for an analogy elsewhere in similar structures. Some of the tests in other parts of the disturbed belt have been very expensive, and there seems to be no means as yet of predicting what conditions will be found at depths of 5000 to 10,000 ft. This belt is a mass of fault blocks. In Turner Valley the productive limestone was tilted along with the beds above. In some of the other deep holes, after penetrating beds known to be normally only a few hundred feet above the lime, it has been found that faults to younger formations have made it out of the question to expect the lime at depths within reach.

TABLE 3
Footage drilled in Alberta

| | 1940 12 mon. | 1941 12 mon. | 1942 6 mon. |
|---|---|---|---|
| Turner Valley | 296,832 | 376,676 | 216,969 |
| Other oil fields | 23,448 | 51,824 | 34,627 |
| Gas development | 1,045 | 16,123 | 0 |
| Exploration | 48,779 | 46,716 | 35,920 |
| | 370,104 | 491,339 | 287,516 |

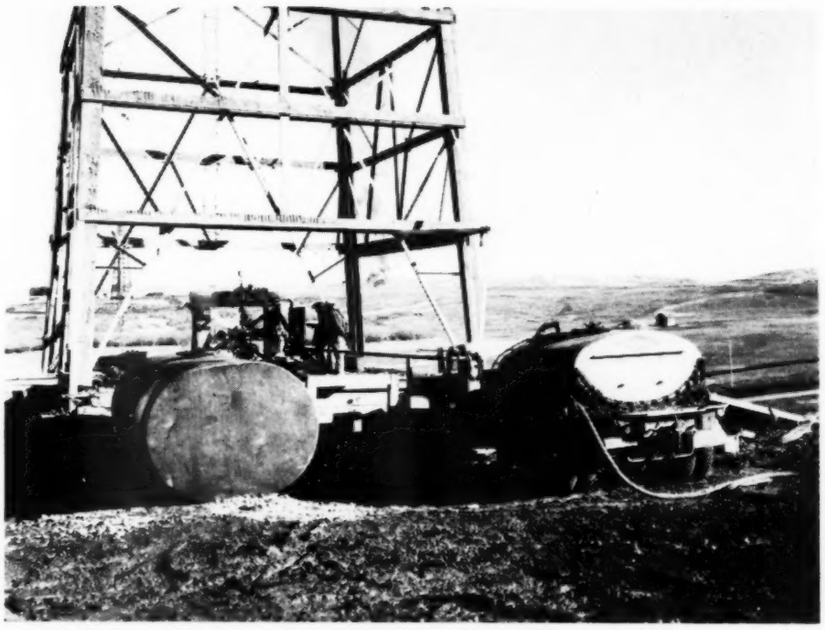
Note: Turner Valley footage includes wells drilled in extension of proved area.

## Turner Valley

A small strike of oil in 1914 precipitated a boom that was shortly punctured by the advent of war. A few of the companies financed in the boom obtained limited yields from sands in the Blairmore formation and small topping plants processed the oil produced.

In 1924 a well was drilled to the limestone and after drilling nearly 300 ft. of lime and the operator was about ready to quit, a large flow of gas was struck. The well was on fire and out of control for a time, but when brought under control and the gas put through a separator, it produced 500 to 600 bbl. a day of naphtha, which could be used in a motor car in its natural state, although the odor and wild fractions demanded refining for commercial use. This one well produced at a fairly uniform rate for about five years and then rapidly tapered off, but during its life it produced about 900,000 bbl., and at prices then prevailing was a great money maker. Very active drilling followed its completion. Wells slightly to the east of the axis through the discovery well, failed to reach the productive zone and in fact failed to find the limestone at all within the rather great depth penetrated. Early wells down the west slope were unfortunate in finding very little porosity in the limestone. As a result, only the gas cap was exploited for about 11 or 12 years. No gas was returned to the producing zone after being stripped of naphtha and reservoir pressure consequently dropped rapidly. Condensation of vapors inevitably took place within the pores of limestone and the condensed liquid could never be produced. More than 8,000,000 bbl. of naphtha was produced in separators and nearly 4,000,000 bbl. by absorption plants, but this is presumably only a fraction of the total oil originally contained in 1,060,000,000 cu. ft. drawn from the gas cap since 1924 to the close of 1941. Actual separator recoveries therefore required production of 130,000 cu. ft. per bbl. and overall recovery including natural gasoline required 89,000 cu. ft. per bbl. Gas withdrawals from early wells were not metered or even measured occasionally, and it is consequently difficult to estimate just what liquid content was originally present, but we have fairly reliable records suggesting ratios as low as 30,000 cu. ft. per bbl. from separators. This suggests that for every barrel recovered at least two and perhaps three or four barrels have been left in place.

In June, 1936, a well on the west flank was completed far enough down the slope to encounter liquid-phase oil, and there are now 192 wells producing from this zone. The field has a length of 20 miles from north to south or to



*All Turner Valley wells are acidized to open up the limestone immediately surrounding the hole*

be more exact from north-northwest to south-southeast. The liquid-phase zone at its widest is a mile and a half wide and is limited at the upper or easterly edge by a gas cap above elevation —2200, and at the lower or westerly edge by salt water at about —4200 to —4500. The gravity of oil produced varies with position down the slope. Just above the water, a gravity of 36° to 38° A.P.I. may be found, increasing eastward. Some wells produce, apparently, both from liquid- and vapor-phase zones and the gravity is as high as 50° or 51° A.P.I., with an average for all wells classed as oil wells of a little less than 42° A.P.I.

By far the most prolific yields have been obtained in the most northerly three or four miles, and there are spaces largely undrilled where only small wells have been completed. Late in 1941 and continuing into 1942 for several months, active prospecting extended for about 12½ miles north of the most northerly producer, but adverse conditions were met in well after well, and the prospecting has almost ceased in that direction.

The quantity of gas produced with oil varies somewhat with the position of the well as between lower and upper limits of the liquid-phase zone, and in general the ratio of gas to oil increases with the age of the well. Only one well that was completed as an oil producer has been abandoned because of water. It showed some water when first completed and water production increased in percentage of total liquid until oil production was no longer economical. Five wells found only water. They reached the limestone at levels below the known position of water-oil contact. Two others have found water in the lower porous zone and on plugging-back have produced oil from the upper porous zone. One of these has produced oil free from water for more than two years. It seems apparent, therefore, that if there is a water drive, it is so small in volume as to be almost negligible, and recession of the upper limit of the liquid-phase zone is quite noticeable.

Production has been 22,000 to 28,000 bbl. per day for two years and for the last 18 months has not declined below 25,000, based on monthly averages. Only by new completions has it been possible to maintain this average. In the week ended September 15, 1941, 162 wells produced a daily average of 27,906 bbl., whereas in the corresponding week of 1942, 195 wells produced 27,529 bbl. daily.

## Drilling Practice

Most of the rigs drilling in Turner Valley are modern, with unitized drawworks, shale shakers, safety devices, and plenty of power from gas-fired steam boilers. Careful attention to mud conditioning is normal practice, and local clay supplies are usually adequate, although a Calgary plant turns out a bentonitic clay that finds some demand when special characteristics of mud are needed. Practically no special weighting has been found necessary.

Rock bits are used from the grass roots and they represent a large item in the budget of cost of a well. Formations above the limestone average 40 to 50 ft. to the bit, whereas a bit is worn out every 10 ft. in the limestone, on the average. Some very hard chert horizons are found in the lime and in these a bit may last only for 1 ft. of hole, but soft, porous zones may be drilled much more economically than the average.

Straight-hole drilling has demonstrated its value. The formations are all tilted, and when hard beds are interspersed with soft ones very serious difficulties were met until the technique of keeping holes straight was mastered. Although twistoffs and fishing jobs still occur, they are much more infrequent than formerly, and an 8600-ft. well was recently completed in 5½ months as against an average of about a year required to drill a 5000-ft. hole 10 or 12 years ago.

Spacing in Turner Valley is now kept at one well per 40-acre parcel. The surface location must be within the central circular acre, and completion within the central 10 acres. If accumulated drift as shown by single shot readings is great enough to put the bottom outside the central 10 acres under the most unfavorable conditions, a directional survey is required, and if necessary, directed redrilling to bring the well within the required position.

Drilling is carried on throughout the year. Sub-zero weather makes operations a little more difficult, but extremely cold weather does not usually last long.

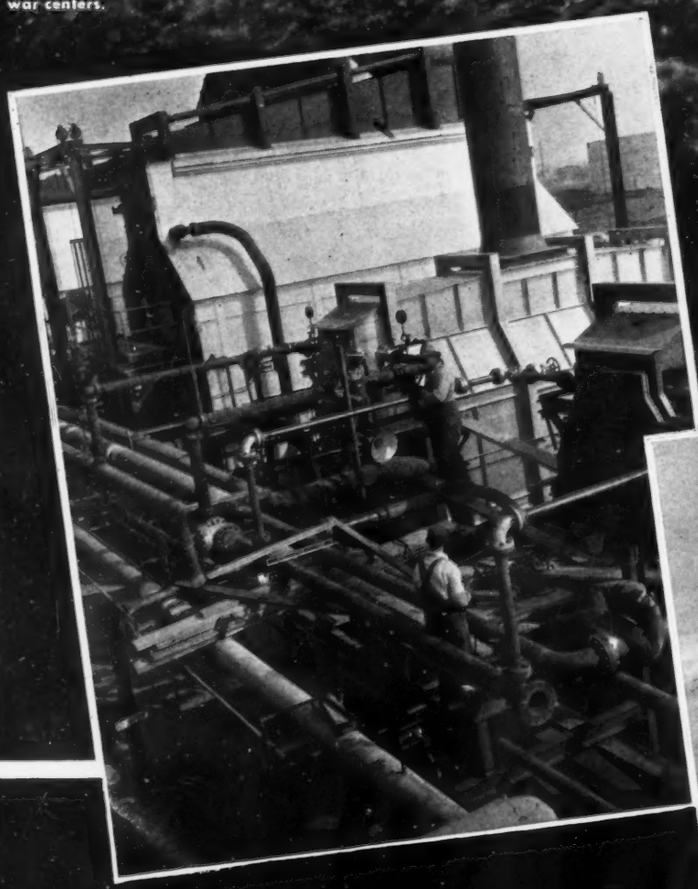
As many as 35 rigs were running last spring during the play to extend the field northward, but the number in Turner Valley has now declined to 21.

With plenty of natural gas available the only deterrent to steam power is ground water containing a large amount of dissolved solids and consequent need for frequent boiler washing. To meet this condition water lines are laid from pumping stations on streams crossing the field. One wildcat rig in the province could get a small gas supply several miles away, and it was feared the supply might be inadequate for steam boilers, so gas engines were installed. Gas consumption has been remarkably low compared with that of boilers.

## Casing

Two strings of casing are now usual practice. A string of 13⅜-in. is set at 500 to 700 ft. and cemented. A 7-in. string is set 10 or 20 ft. into the top of the limestone and fully cemented; 2½-

(*Continued on Page 62*)



*AMERICA has the world's largest network of pipe lines that deliver gasoline and oil quickly and safely to vital war centers.

THE TANKER FLEET is the life line of our mechanized forces. Its crews are doing yeoman service in delivery of oil and gasoline to all corners of the world.

**100-OCTANE GASOLINE** gives American bombers the longer range and greater speed that help win victories.

**FIGHTING TANKS** become lame ducks if their fuel supply gives out. It takes the coordination of all types of transportation to keep an offensive rolling.

# *Pipe* PUTS AMERICA'S OIL TO WORK *fast!*

OIL is where you find it. But the important thing in the war program is where it's delivered, and how quickly. Filling the tanks of bombers in Australia, fighters in China, and thousand-plane armadas in England is an undertaking that is challenging the ingenuity of the best minds in America today.

Fortunately, the American oil industry has already built an amazing transportation system—the world's largest network of pipe lines. These lines are delivering oil and gas quickly and safely to most of our important industrial districts as well as large quantities of gasoline to tanker loading ports. This vast network will be extended. The new 550 mile, 24-inch seamless pipe line, the largest oil line in the world, is now under way — and plants of NATIONAL Tube Company are turning out this huge pipe at the rate of over a hundred miles a month.

In addition to forming the backbone of this major distribution system, pipe and tubes of special grades make possible the ceaseless 24-hour grind of refinery operations. Here they serve as crude supply lines, high temperature and high pressure lines, cracking still tubes, and in many other services, all geared to one dominant consideration—maximum production for our fighting forces.

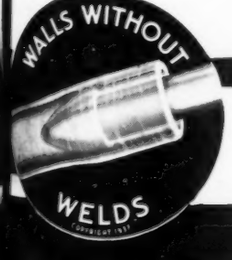
All in all, Uncle Sam's oil industry is doing a grand job in the war program. It is not only supplying many of the United Nations, but is producing oil and gasoline for certain of our civilian uses, too. This achievement is not duplicated anywhere else in the world. Congratulations to America's oil industry!

## NATIONAL TUBE COMPANY

PITTSBURGH, PA.

United States Steel Export Company, New York

UNITED STATES STEEL




# NATIONAL SEAMLESS

(*Continued from Page 59*)

or 3-in. tubing is used for producing the well. Most wells need high-pressure gas to kick them off. A few may need gas lift for several months, and intermitters have been tried, as well as a bottom-hole pump. Normally, however, a string of tubing with suitable wellhead connections has been adequate for producing the well.

### Acidizing

All Turner Valley wells are acidized on completion. In some cases as many as 10 shots were needed before it was felt sufficient resistance had been broken down. In other cases, a single wash shot seemed to be sufficient.

### Production Characteristics

To the end of 1941 wells listed as "oil wells" have produced 33,500,000 bbl., of which 9,500,000 bbl. were produced in 1941, 8,100,000 in 1940, and 7,200,000 in 1939. Gas produced with this oil amounted to 117,000,000,000 cu. ft. or an average of 3500 cu. ft. for each barrel produced. Against this we have at one end of the scale wells, notably in the prolific north end of the field, that have sustained production at only 666 cu. ft. per bbl. over monthly periods. At one well after three and a half years the ratio has risen only to about 1100 cu. ft. per bbl. At the other end of the scale, we have as an example a well toward the south end of the field that was allowed to produce 1135 bbl. per day for 26 days in one of its early months. Just before this it had a ratio of 1200 cu. ft. per bbl. In five years of production it has produced more than 380,000 bbl., and its ratio is now up to 36,000 cu. ft. per bbl., placing it, according to strict interpretation, in the gas well category. Heavy withdrawal rates in its early life evidently drained liquid oil from up the slope and set up direct connection with the gas cap. Gas entering the well from the gas cap carries some vapor-phase oil, and to this is added only a minor quantity of oil from down slope or to the sides.

At a probable initial bottom-hole pressure and temperature for this well, some 600 cu. ft. of gas was dissolved in each barrel of oil. Hence, at its most favorable performance this well bled the motive force from a barrel of oil left in place for every barrel recovered. Just how far this process of taking gas from trapped oil goes is difficult to say because of the probable entry of gas from the gas cap. Consideration of this condition leads very definitely to the observation that bleeding of gas from oil left in place must account for large quantities of oil being left in the formation, and the quantities so left must be much greater in proportion than the condensed vapors left in the gas cap.

Without trying to explain why, it is in order to record a related fact. A well having a low gas-oil ratio was pulled for two or three days to get fuel for some purpose. The gas-oil ratio immediately rose, and after putting it back under normal wellhead pressure, the ratio did not settle back to normal for several months.

### Reserves

Porosity and permeability of limestones are most erratic. In most of the field there are two porous zones, but in some places there are three. The normal two zones may be present, but the permeability of one zone or the other may disappear in some localities, and there have been wells that failed to produce commercially for lack of porosity as well as permeability.

For a time operators were required to core a part of the porous zone in each well, and some studies of porosity and permeability were made. It soon appeared that the most prolific producing portions yielded no cores, as the limestone broke up in the core barrels, and the only cores obtained were in the less porous rock. This condition, coupled with the fact that good wells are often offset by moderate to poor wells, makes estimates based on pore space very hazardous. Depletion characteristics of various wells are also erratic, but they form better criteria as to reserves than estimates based on porosity. For most wells, a graph of accumulated production against age of the well, with gas-oil ratio and bottom-hole pressure plotted alongside will give a fair means of estimating ultimate yield. The actual estimated reserves of the field at the present time are not available, but it is quite certain that the reserves possible of recovery at any well are subject to considerable variation dependent on whether operation conserves or wastes gas, which is the only motive power for bringing oil to the well, and the principal motive power for raising oil to the surface.

### Price of Oil

Turner Valley oil measured in stock tanks at the well and with delivery accepted there, is computed to the volume as at 60°F. and 0.075 percent deducted for pipe-line loss. Oil of 41° to 41.9° A.P.I. is priced at $1.51 with 2 cents added for each degree above, or deducted for each degree below. This brings the price for 64° A.P.I. oil to $1.97. Some gas wells still produce some naphtha of this gravity or higher, but no increase is made in price above 64° A.P.I. Four absorption plants process gas for recovery of natural gasoline, and payments are based on $2.28 per bbl. The posting calls for this price for 20-lb. Reid vapor pressure or for $2.44 for 17-lb. Reid vapor pressure, but recent transactions have all been on basis of 20-lb. Pipe-line deduction of 2 percent is applied to natural gasoline.

Under the Wartime Prices and Trade Board, no increase in price is permitted.

### Rationing of Gasoline

Beginning March 1, 1942, gasoline could be purchased only on surrender of coupons. The lowest category, pleasure cars, received 60 coupons for the 12 months. In the prairie provinces each coupon is good for the purchase of 5 gal., but in other parts of Canada the unit has had values somewhat smaller and dependent on available supplies. The Imperial gallon, by the way, is 20 percent larger than the U. S. gallon. A recent announcement cut pleasure cars to 16 coupons for the six months and became effective October 1.

In the prairie provinces, so far as can be observed, rubber restrictions have been more potent than gasoline rationing, and rationing is generally accepted as a wartime need. As a wartime measure grades of motor gasoline have been limited to two, and the quality of these grades is specified. This order has eliminated from the retail trade the third grade gasoline formerly available. It does not affect aviation gasoline or tractor distillate.

The Dominion government collects 3 cents per gal. tax on gasoline. To this is added provincial taxes that amount to 10 cents per gal. in the maritime provinces, 8 cents in Quebec and Ontario, 7 cents in the four western provinces.

☆☆☆

## Steel Scrap Drive Yields Half Million Tons

The intensive campaign conducted by the petroleum industry for the dismantling and scrapping of obsolete equipment, plus a thoroughgoing clean-up of field rigs and tools, has yielded half a million tons of scrap for American steel mills to date, M. R. Singleton, WPB Salvage Director for the petroleum industry, states.

Sources for scrap still remaining, he pointed out, include the following:

Refineries: Obsolete units such as old stills, cracking plants, heat exchangers, obsolete inventories, etc.

Production: Worn-out drilling rigs, oilfield boilers, metal in counterweight boxes, old derricks, and general field scrap.

Transportation: Tank-car repair shops, pipe-line scrap, broken tools, pipe, etc.

Marketing: Obsolete gasoline pumps, worn-out compressors, lifts, hoists, lubsters, etc.

# Progress in Reservoir Technology

*PART 4 (Concluded)*

*by Morris Muskat*

Chief, Physics Division, Gulf Research and Development Company

## Well Spacing

ONE of the earliest problems placed before the production technologist was that of well spacing. In its realistic sense this problem simply states the question: what should the well spacing be in order to achieve the maximum profit from the development? The answer must obviously rest upon the economic balance between the value of the oil recovered and the cost of drilling and operating the wells, each expressed as a function of the well spacing. From the viewpoint of reservoir technology, the crux of the problem evidently lies in the effect of the well spacing on the efficiency of oil recovery. The calculation of exploitation and operating costs, although subject to a variety of assumptions, nevertheless can be carried through by well-standardized accounting methods.

Prior to the last decade the only available information bearing on the problem of efficiency of oil recovery as a function of well spacing was that derived from direct field experience. This consisted of examining the records of cumulative oil production for various fields, or different properties within a single field, and correlating these with the well spacings under which the oil was produced. Such correlations seemed to indicate rather strongly that the oil recovery per unit surface area increased as the well density increased.

Although the observed field data cannot be denied, their interpretation is now known to be a matter of serious question. Thus, because each field is quantitatively an entirely different system from every other field, it is obviously unjustified to attribute differences in oil recovery solely to differences in well spacing. Moreover, it is *a priori* probable that those early fields that were drilled with close well spacings were so developed mainly because it was observed that the producing formations were inherently more prolific and, hence, could bear a more dense exploitation pattern. Conversely, less prolific formations could not support close well spacings. Thus, one would obtain the previously indicated correlations even though the well spacing in itself had no direct influence on oil recovery.

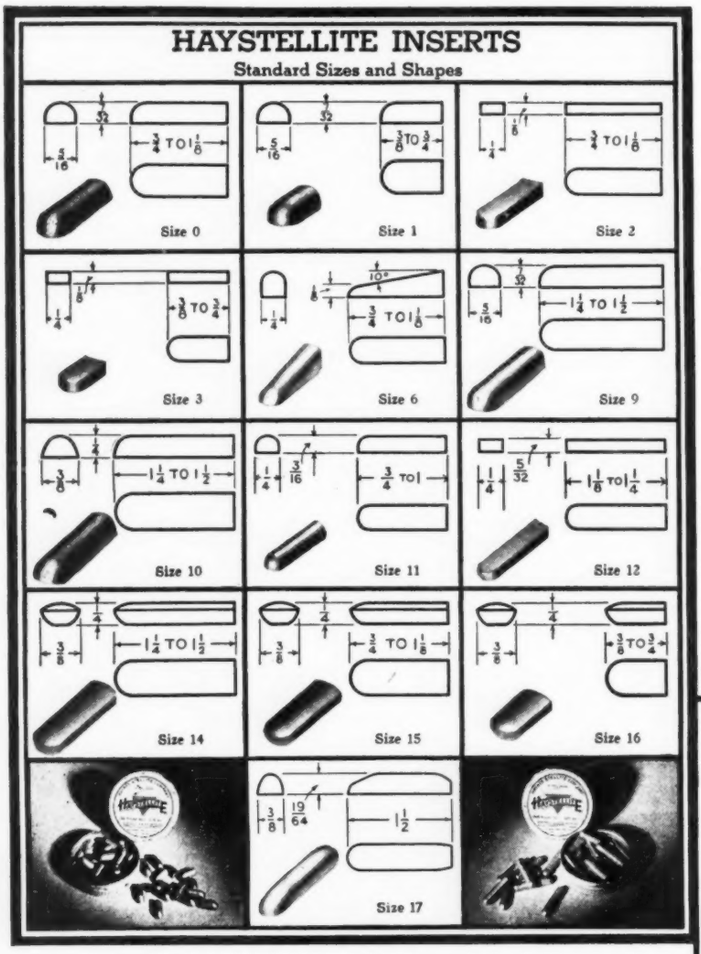
With respect to data on neighboring properties in the same field, an additional factor, previously ignored, makes very questionable the apparent correlations. This factor is the fluid migration between adjacent acreage induced by pressure gradients. As under wide open production a closely spaced lease will lead to a more rapid pressure depletion than a sparsely spaced lease, a migration of oil from the latter to the former will develop and tend to equalize the pressures. The densely spaced property will thus be supplied oil from the adjacent acreage, and hence yield excessive oil recoveries at the expense of the neighboring leases that it drains. The conclusion that close well spacing leads to higher ultimate recoveries thus again may be merely the result of extraneous circumstances rather than a reflection of an inherently greater efficiency of the high well density development.

Perhaps an even more potent factor in the encouragement of close well spacing than the questionable inferences from so-called field data was the prevailing theory of the landowners' equity in an oil reservoir. This was the conveniently expedient "rule of capture." Without entering into the legalistic technicalities of the matter, this rule proclaimed, in effect, that to the landowner or the producer belonged all the oil yielded by wells on his properties, no matter if it originally resided under the neighboring acreage, and regardless of any detrimental effect the production of that oil may have had upon the surrounding properties. Indeed, the existence of such oil migration or interactions resulting from operating conditions on neighboring leases was neither recognized nor countenanced. This concept or situation was not the child of the oil-producing industry. On the contrary, it was a code for practice foisted on it by legal decisions based on the rationalization of ignorance. Yet it did provide a convenient vehicle for the inducement of close well spacing exploitation as the surest means for individual operators to obtain maximal oil recoveries for themselves.

Despite the fact that, in general, laboratory experimentation is necessarily restricted to idealized conditions, one is nevertheless forced to consider such investigations as the most reliable arbiter of the well-spacing question. In the last several years these have shown quite conclusively that in uniform formations produced by internal gas drives, the physical efficiency of oil expulsion is essentially independent of the well spacing. The same applies to fields subjected to edgewater drives. This is a consequence of the detailed mechanics of the displacement of oil by gas or water. In particular, the latter does not vary appreciably with the pressure gradient or rate of flow within the range of variation of these variables that it is practicable to achieve by any reasonable variation of the well spacing. It is true that in the immediate vicinities of the well bores the velocities may be already so high as to make the oil displacement efficiency somewhat sensitive to such variations as may be controlled by the well spacing. The region in which this sensitivity, however, is appreciable is so localized about the well bore, and hence of such small areal extent, as to be of negligible practical significance.

From a physical viewpoint, therefore, there is, in general, no basis for preferring close to wide well spacing, or vice versa. Nevertheless, from the practical and economic standpoint, there is indeed a basis for distinction. In fact, even in terms of the ultimate oil recovery that may be produced profitably, i.e., the economic ultimate recovery, elementary considerations predict some variation of the well spacing. Thus, if we suppose that each well must produce

# To produce most efficient drilling tools—
## *use Haystellite Inserts and Tube Rod*



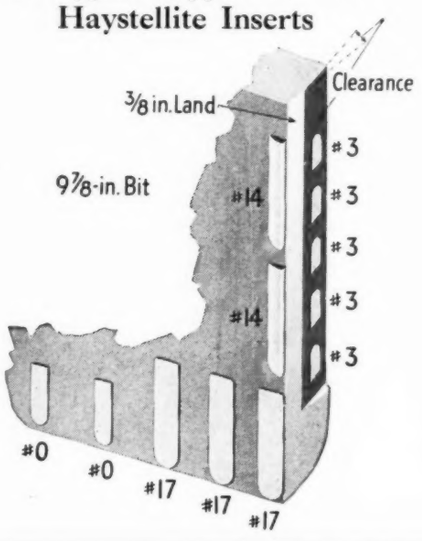

GOOD bits, correctly set with Haystellite inserts and faced with Haystellite tube rod, can be depended upon to make more footage of straight, out-to-gauge hole per round trip.

Haystellite cast tungsten carbide inserts are *hard* enough to withstand severe abrasion, and *tough* enough to withstand shocks. And to assure uniform performance, every Haystellite insert is rigidly inspected before it leaves the factory.

There is a size and style of Haystellite insert for every type of bit, as shown at the left. And Haystellite tube rods are available in 5 tube diameters and 8 different standard screen sizes of tungsten carbide particles.

For the most outstanding drilling performance and the lowest drilling costs, standardize on Haystellite inserts and tube rod for hard-setting and hard-facing all of your drilling tools!

### A Typical Application of Haystellite Inserts




*Haynes Stellite Company* ***can help you.*** The slight extra care required to make each drilling tool the *best* it can be made is more than repaid by more dependable performance and lowered drilling costs. We have the experience and the organization to help you use Haystellite products to obtain best results at lowest cost. Call on us, without obligation.

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at a rate greater than a preassigned value in order to yield a profit, it may be shown that even though the physical ultimate recovery will be independent of the drainage area, the actual recovery from a given surface acreage may increase, though not proportionately, with the number of wells. This will be clear on considering the special case where the limiting production rate per well is very high, and the total economic ultimate recovery is but a fraction of the physical ultimate recovery. Of course, for abandonment rates of the magnitude obtaining in practice, the economic ultimate recoveries will generally approximate closely the physical maximum recoveries. The increased recoveries under close well spacing may then become quite negligible as compared to wider spacings.

Even should there be a tendency for the economic ultimate recovery to increase somewhat with the well density, this in itself does not provide the answer to the well-spacing problem. For obviously it would be economically unsound to increase the well density if the increased production before abandonment would not pay for the cost of the additional wells. Indeed it is only by balancing the added value of the production against the increased investment and operating costs that the true economic optimum well spacing may be determined. In particular, we must look for the maximum in the difference between the curve for the income from the oil recovered and the cost of the development and operation, each plotted as a function of the well spacing. In determining each of these, account must be taken of the effect of the well spacing on the life of the operations and the interest charges on the investment and discount rates for future profits. It is thus found that the curve for income from oil recovery rises rapidly at first and then quickly flattens out as the well density increases. On the other hand, the cost curve maintains an approximately linear rise throughout the whole range of practical spacing variations. The optimum spacing—that for maximum profit—is then the abscissa for maximum difference between the curves, or for equal slopes. For physical and cost constants of such magnitudes as are encountered in practice, this method leads to optimum spacings for gas-drive fields as are actually indicated by direct field experience, namely, 20 to 100 acres per well.

Thus it is seen that by a combination of technical developments and sound economic principles, it has been possible in the last decade to construct a practical and well-founded theory of well spacing. Although in its present state it is not all-inclusive of every type of producing system, it certainly provides the framework for applications to a number of major classes of oil reservoir. In any case, one can no longer hide under the cloak of the rule of capture as a screen for justifying excessively close well spacing. This development alone is an achievement of far reaching significance.

### Proration

The change experienced by the oil-producing industry that is perhaps the most symbolic of the last decade as a unique period in our history, is that of proration. Governmental restriction of the actual output of an item of material wealth to below the productive capacity of the established industrial organization has indeed not been limited to the oil industry. Nor is the full story told without reference to the fact that the government has not been alone in the limitation of the actual supply of material goods below that which could be provided by the available productive capacity. A judgment of the merits of such artificial controls lies beyond the scope of the present article. Yet, whatever its ultimate evaluation may be, it very definitely represents a most important development of the period under review.

From the technical standpoint, proration has had two major effects. First, as implied by the definition of the term, it has forced the operation of wells and fields at lower production rates than possible by wide open flow. Second, it has created the problems of proration formulas, and allocation of production, which, in turn, have stimulated much of the progress already discussed.

The immediate consequence of limiting individual well, lease, or field production rates is obviously a lengthening of the producing life of the reservoir. This, in itself, does not, of course, imply an increase in total oil recovery or improvement in operating efficiency. Yet it has had the extremely important incidental result of bringing into play the operation of edgewater drives that might have been entirely ineffective under wide open flow exploitation. Thus the associated retardations of pressure declines have been due not merely to the lower rates of fluid withdrawal but also to the repressuring effect of the natural water drives. All the implications previously discussed of water-drive field operation have thus naturally been given expression. In most cases the proration restrictions have not been of sufficient severity to force a complete suppression of the gas-drive production phase. In some instances, however, the allowed field production rates have been so low as compared to the wide open flow capacity that the edgewaters could fully replace the fluid withdrawals and thus arrest the pressure decline completely for extended periods. To the extent that production under natural water drives is inherently more efficient for oil recovery than unrestricted wide open flow, proration must be credited with a very important achievement.

The problems of formulating and putting into effect proration regulations have also led to advances in production engineering of major significance. It is true, of course, that such arbitrary rules as fixing the allowable

*(Continued on Page 70)*

## *OPA Exempts Drilling Services from Price Control*

Services for the drilling of oil and gas wells and for extinguishing oil-field fires have been exempted from price control by the Office of Price Administration.

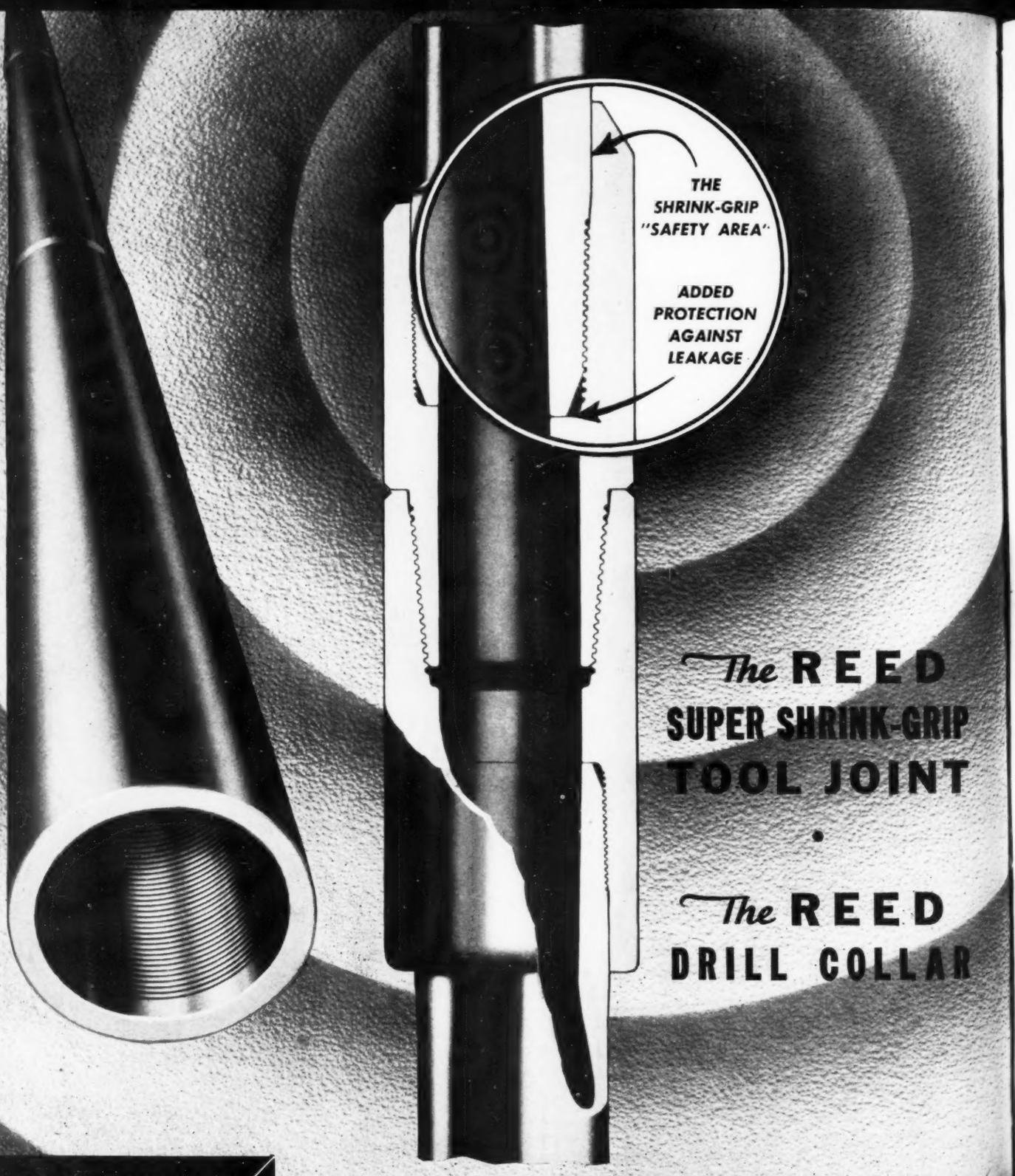
The exemptions contained in Amendment No. 7 to Revised Supplementary Regulation No. 11 to the General Maximum Price Regulation, effective immediately, were granted because each individual well presents its own particular problem and no fixed price or standard of pricing can be made to apply to all cases.

In many cases, OPA pointed out, the contract price for drilling is payable in cash, whereas in others the contractor agrees to take an interest in the well. Differences in terrain, proximity to water, fuel and supplies, depth, size of hole, number of strings of casing needed, number of cores to be taken, amount of risk assumed and many other factors enter into the fixing of the price for each individual drilling operation.

The exemptions granted cover all necessary operations in connection with well drilling, such as preparation of location, fishing jobs, pulling, salvaging, and plugging operations.

Extinguishing oil or gas well fires is highly specialized work. Agreements on the price to be charged are usually reached after an examination of the blaze. The operation, although sometimes requiring months, may under certain circumstances be concluded in only a few hours.

# *How to Lengthen the Life of Your* DRILLING EQUIPMENT




*The* **REED**
**SUPER SHRINK-GRIP**
**TOOL JOINT**

•

*The* **REED**
**DRILL COLLAR**

P. O. BOX 2119
HOUSTON, TEXAS

**REED ROLLER**

# A *Must* IN WAR TIME

# A *Good Idea* ANY TIME,

## A few suggestions that will give you the *"EXTRA LIFE"* that is built into

# REED TOOL JOINTS and DRILL COLLARS

## CARE OF TOOL JOINTS

### *USE YOUR THREAD PROTECTORS*

Leave thread protectors on tool joints until pipe is put into use.

### *CLEANING* and *DOPING*

Clean joints thoroughly, removing all grease and dirt.

Before screwing together, dope threads thoroughly with a good grade zinc base lubricant.

Steam or wash out inside of new pipe before running in the hole to assure removal of all shavings, mill scale and foreign matter, which may damage threads.

### *STABBING* and *TONGING*

Joints should be tonged up tightly before running in the hole, and under no circumstances should the torque applied to the string in drilling be depended upon to tighten the joints or keep them tight.

### *CAREFUL INSPECTION*

Inspect shoulders and threads before running in the hole each time and keep threads well doped.

Replace thread protectors when pipe is moved to new location.

## CARE OF DRILL COLLARS

The suggestions concerning the use of thread protectors, cleaning and doping, tonging, etc., may be followed in the care and maintenance of Drill Collars.

The maintenance of alignment is also of paramount importance and cannot be stressed too highly, as the resultant whip of a mis-aligned drilling string is both dangerous and costly.

### *MAINTENANCE OF ALIGNMENT*

Support the drill collar throughout its entire length when it is placed upon the pipe rack.

Exercise extreme care while handling to protect the shoulders and threads.

When lifting the drill collar use a wrap in the middle and at both ends to protect alignment.

Bulletin T-1041 on the care and maintenance of Reed Tool Joints will be sent upon request.

Various instruction sheets are also available on the care and operation of the Reed "Kor-King" and Reed "BR" Core Drills, and on the correct selection of Jet Sizes for Rock Bits.

**BIT COMPANY**

EXPORT OFFICE
30 ROCKEFELLER PLAZA
NEW YORK, U. S. A.

(*Continued from Page 67*)

production purely on a well basis have resulted in some instances in excessive drilling. Nevertheless, the very process of the gradual evolution of more scientific and equitable criteria for production allocation and the elimination of unsound formulas have in themselves been of inestimable value in encouraging the growth of reservoir technology as a true science. In fact, it is perhaps just because proration has been such a controversial subject and has led to so many legal hearings that it has provided the most potent educational stimulus for the dissemination of basic reservoir engineering principles that the industry has enjoyed.

A specific example of the impact of proration upon the scientific concepts of petroleum production is represented by the term "well potential." There can be little question but that the present-day well-defined meaning of this term was the direct outgrowth of the introduction of the well potential into proration formulas. Thus when the well potential factor was first proposed it was generally interpreted as a measure of the open flow capacity of the composite well and pay system. The costly attempts to lower the flow resistance of the well bore itself, in order to obtain high open flow ratings, were finally dropped only when it was recognized that it is the productive capacity of the formation, rather than the flow string, that should enter a proration formula. On the other hand, it became possible to remove the effect of the well bore from the potential measurement only as the accurate instruments for bottom-hole pressure measurements became available. Then, too, the problems of storage of the production from open flow tests of high capacity wells forced the realization of the fact that the production rates for known pressure differentials should suffice in determining the potential. As a result we have been led to the use of the productivity index as the basic measure of the true capacity of a well to produce. Thus, whereas much of this development was only incidental to the general question of proration, it certainly did gain in impetus from its direct application to the proration problem.

The whole complex of problems of the allocation of oil production has been brought to the foreground, if not entirely created, by the advent of proration. No pretense can be made here of having achieved a solution to these problems. Just how the formation productivity, the local reservoir pressures, surface acreage, and formation thickness should enter the allocation formulas are still moot questions. Yet at the very least a much clearer understanding of the mechanics of oil production has been evolved from the intensive studies and discussions of these matters. This, too, even though a by-product, is a distinct contribution of proration as a factor in oil production.

### Conservation

It is much more than a political or patriotic gesture to conceive of the sum total of the advancements here discussed as major steps toward the conservation of one of our most important natural resources. Very significant developments, such as improvements in drilling methods, mud control, pumping equipment, chemical treatment of wells, and geophysical exploration have contributed immeasurably toward the more efficient exploitation of oil-bearing formations. These, however, merit individual review and treatment. The scope of these remarks has been deliberately restricted to those aspects of oil production pertaining to the oil-bearing reservoir itself.

Although in our democratic system of free enterprise the profit motive has naturally played a vital role in controlling the course of the development and growth of the oil-producing industry, this has in no sense been pursued at the expense of the national interest. On the contrary, every major technologic advancement has borne fruit in increased profits only to the extent that increased efficiency in oil recovery has been achieved at the same time. Indeed, many of the accepted practices of oil-field operations, such as core analyses and bottom-hole pressure surveys, find more direct application in the furtherance of conservation than in immediate profits. The ready adjustment to and acceptance by the industry of proration and other legal restrictions, such as gas-oil ratio limitations, are a tribute to the vision of the industry and its realization that profits on capital investment and the national welfare go hand in hand. By their nature, they are mutually consistent and interdependent, rather than contradictory.

During this last decade the oil industry has really learned intimately for the first time the nature of the reservoirs from which it draws its oil. It now can measure and specify their properties. It can evaluate them. It understands them. It knows what to expect of them. It has learned how to conserve the energy associated with them and use it most efficiently to insure a maximum recovery of oil at a minimum cost. It has transformed the art of oil production into the science of reservoir technology. Unwittingly, or perhaps by the benevolent guidance of Fate, it has prepared itself to contribute its full share for victory, not only for itself but for the whole of our civil and industrial life, of which it is so vital and integral a part.

☆ ☆ ☆

## *Effective Date for New Production Diamond Core Drill Fittings Extended*

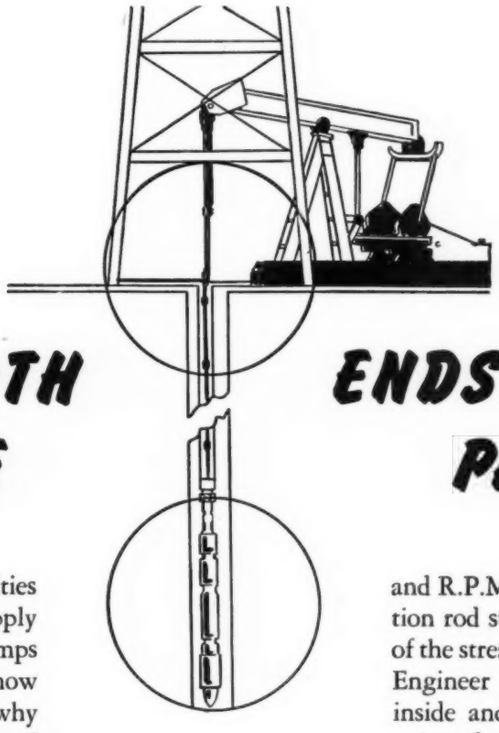
Under date of September 25, 1942, the Diamond Core Drill Manufacturers Association requested the National Bureau of Standards for a second extension of the effective date for new production of diamond core drill fittings in accordance with the new parts of Commercial Standard CS17-42 for the following reasons:

"The new standards do not so much result in the simplification of the present standards as specified in CS17-32 as to set up new standards of thinner wall bits. These thin wall bits are not greatly used in the United States at the present time, although they have come into extensive use in Canada, where they have already been standardized.

"It is expected that eventually CS17-42 will completely replace CS17-32, but from the nature of the art, it will take months to effect this replaeement."

Agreeable to this request in the war emergency, and with the approval of the Standing Committee of the Bureau of Standards, the effective date for new production of diamond core drill fittings, according to Commercial Standard CS17-42, has been extended from January 1, 1943, to six months after official announcement of cessation of actual hostilities, or to such earlier date as may be recommended by the Standing Committee, it is announced by I. J. Fairchild, Chief, Division of Trade Standards.

In the meantime, the existing Commercial Standard CS17-32 will remain in effect.



# PLAYING BOTH ENDS AGAINST THE MIDDLE PAYS HERE!

METAL SHORTAGES and war priorities make it increasingly difficult to supply you with any deep well plunger pumps and sucker rods. The equipment you now have must last a long time. That is why Axelson Service Engineers are interested in seeing that your present equipment will give maximum production at minimum cost for power and maintenance as long as this critical material shortage exists.

To get this maximum performance and operating life from your string of rods and pump, from the derrick floor to the bottom of the well, it is necessary to use the right power, stroke and speed. This statement is made because many pumping wells are under or over powered with incorrect pump bore, stroke, and R.P.M., and in the case of combination rod strings an unequal distribution of the stress range. Your Axelson Service Engineer knows your pump and rods, inside and out. He knows all the fine points about Axelson plungers—together with countless other factors concerning Axelson seats and balls, cages, collars, and final assembly, that give you assurance of long pump life at the bottom of the well. By helping you make correct adjustments, he can lengthen rod life and save needless down-time and expense, time-consuming repairs. He can help you play "both ends against the middle" to preserve equipment and maintain production. Contact your Axelson Service Engineer or Axelson Service Store today. Make your equipment last to beat the Axis.

*Write for your copy today*

**WHAT TO DO WHEN**

1. *How to take an Axelson Pump apart.*
2. *What to look for in the nature of wear or essential adjustment.*
3. *How to properly order replacement parts.*
4. *How to properly reassemble Axelson Pumps.*

These and other typical questions on Axelson Pump care and maintenance are covered fully in Axelson's Pump Service Manual, copy of which will be sent to you upon request.

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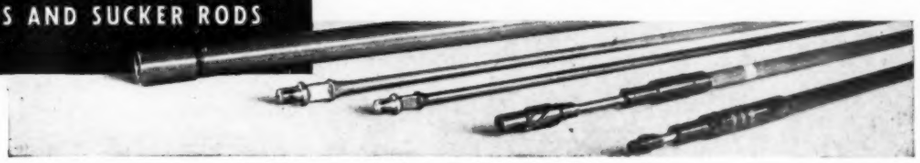
**AXELSON** SELLS AND *SERVICES* DEEP WELL PLUNGER PUMPS AND SUCKER RODS



# Oil Recovery by Under-Pressuring

Exclusive

☆ Operators in eastern areas find method effective in increasing production

*by F. R. Cozzens*

District Field Manager, Equity Oil and Gas Company

IN SECONDARY recovery it is logical to confine the force or pressure exerted by air or gas drive to areas of a pay sand that contain the highest percentage of oil. Generally, these are the top and central portions. The base, or lower portion of most sands usually consists of coarse and broken material, and is the natural basin for water and residue drainage from the entire sand body. It is customary, therefore, to cement or plug-off the bottoms of input or intake wells so that the base or extreme low portions of sand remain so far as possible, unaffected by artificial pressure. This is advisable in the early stages of secondary recovery, but after the pressured zones have been partially depleted of oil, and channeling and bypassing of air have become troublesome, the operator becomes aware of the fact that if production is to continue by this method, the pressure can and must be used to replenish the producing areas, as well as to raise the oil to points where it can be recovered. One such method, gaining steadily in popularity with eastern operators, is that of "under-pressuring," or subjecting the lower portions of the sand to high-pressure air or gas while the pressure in the productive portions of the zones is reduced, the object being to force marginal oil into the depleted zones, and raise the fluid into production channels.

## Method of Under-Pressuring

Under-pressuring begins after a secondary recovery method has been in effect for some time. The method constitutes removing the false bottoms of certain of the intake wells, and lowering the air-induction tubing so that the extreme low sections of the sand will receive the repressuring medium. To confine the pressure, packers are usually run and set in the string immediately below the areas of sand that have previously been pressured. There is no methodical rule regarding the number of wells to be thus treated, but most operators use a ratio of one-third their intake wells, situated at various points over the field. When the estimated number of wells have been deepened and recompleted, air or gas is forced into them at full capacity and as fast as the sand will take it. As pressure builds up, the pressure on the remaining input wells in the upper sand zones is gradually reduced until only sufficient pressure is maintained to push the oil to producing (open) wells. Pressure to the deepened wells, however, is continuous, and a built-up pressure of 300 to 500 lb. is necessary for best results.

As air-pressure increases in the base of the sand, the fluid content (oil, water, and other drainage) expands and rises. The oil, being lighter, is first to enter the producing sand zones, and is later followed by water. A good percentage of oil is generally recovered before water becomes troublesome in the pumping wells, but even as water increases in volume, the operator still benefits. The rise of water in the sand floods the channeled-out portions and acts as an effective remedy for the former bypassing of air. The increasing water volume likewise has a tendency to release considerable oil from side margins of the sand, and to float oil from crevices and pockets that cannot be reached by air or gas pressure alone. Combined pressure (air or gas and water) from below keeps fluid always within the scope of producing wells throughout the entire life of the recovery project.

## Injection Well Completion

As recovery proceeds, certain of the deepened wells may be re-plugged at the bottoms, and the tubing raised in order that upper sand zones can again be pressured while other intake wells on the property are fitted for low sand pressuring. When sufficient pipe and packers are available, some operators prefer to use the same wells for both high and low sand pressuring. Tubing of different diameters (one inside the other) are passed down the casing and packers seated in the respective zones. As many as five different sand zones may be pressured from the same well in this manner, and it is especially adaptable to oil sands of considerable thickness. On many of the shallow wells (1000 ft. or less in depth), a number of operators continue to resort to the old-time custom of using a single tubing string, 2 in. in diameter, in the casing and isolating the lower sand zone by a packer made of rope-cuttings and cement. As many of these shallow wells were not chambered at the extreme bottom when drilled, operators make the low sand zones more receptive to air by cracking the well bottoms with a light charge of nitroglycerine (10 to 15 qts.). This cracking process gives especially good results in areas where the sand body is narrow and inclined to dip.

Thus, with whatever equipment is available, the operator devises methods to under-pressure practically every part of his territory. Continuous under-pressuring interferes in no way with either continuous or intermittent (slugging) air or gas injection in the upper sand zones. The only requirement is that pressures in the upper portions of the zone be reduced as under-pressure is built up, permitting a more uniform rise of fluid. Considerable experimenting regarding the most efficient pressures to be maintained in the upper sand zones can be eliminated by having cores taken and analyzed from different areas of the sand. Many individual operators, however, do not have access to coring service, so the general rule is to plan pressuring by careful study of the sand's performance during its period of flush production. Measurements should be taken in each well to determine high and low points of the sand, and its general thickness.

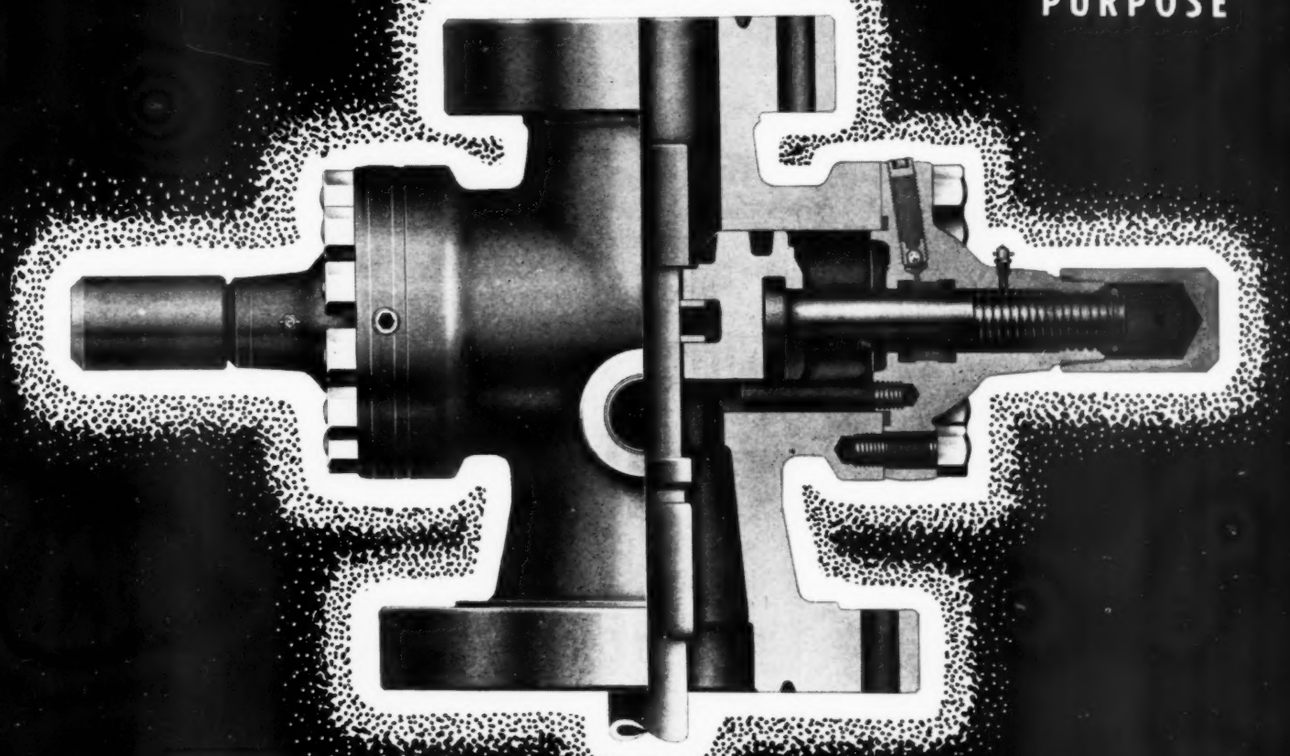
Records taken of operations in many eastern areas show that where under-pressuring was used on a project, from 10 to 20 percent more oil was recovered. In several areas when regular secondary recovery methods employed had begun to decrease in production, there were favorable increases in oil output after low sections of sand had been pressured continuously from three to six months. There was practically no extra cost in operations except that more continuous pumping was required in districts where salt-water was troublesome. Research has shown that with the customary practice of pressuring only the top and central zones of a pay sand, much oil is forced down into the base and lost, along with what percentage of oil the base normally contained. Under-pressuring is a very effective way of preventing such loss of oil, and in various other ways it is proving an essential part of modern secondary recovery.

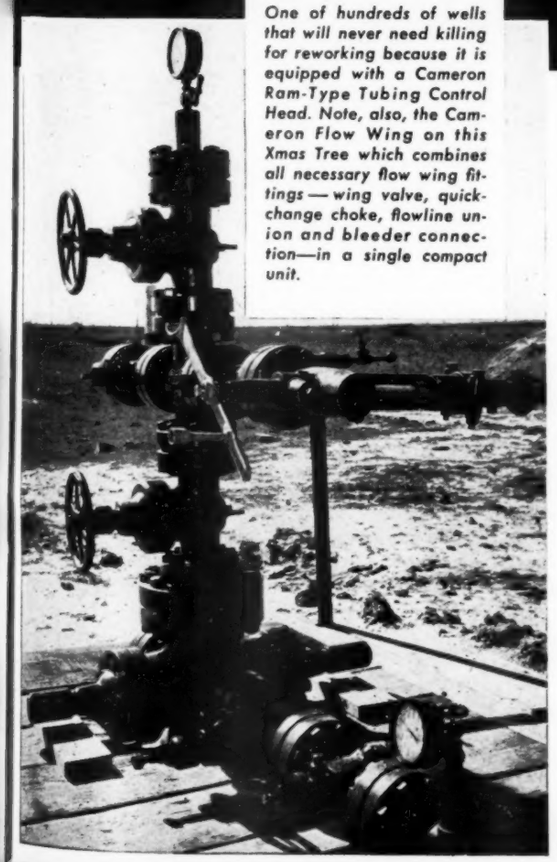
☆ ☆ ☆

*Modern tubing heads do more than simply seal and suspend tubing . . .*

# CAMERON'S RAM-TYPE TUBING CONTROL HEAD

*Serves a* **FOUR-FOLD PURPOSE**





*One of hundreds of wells that will never need killing for reworking because it is equipped with a Cameron Ram-Type Tubing Control Head. Note, also, the Cameron Flow Wing on this Xmas Tree which combines all necessary flow wing fittings — wing valve, quick-change choke, flowline union and bleeder connection—in a single compact unit.*

These rugged ram-type tubing control heads employ numerous mechanical features of the famous Cameron Blowout Preventer; yet, with all their exclusive performance characteristics and proven design these heads actually cost little, if any, more than conventional "set screw" type tubing heads.

They provide the ultimate in safe, dependable control during every step of completion operations. The full opening vertical bore freely passes drilling-in tools, liner and screen, and packers. Its rams, provided with patented Cameron Self-feeding Packing Elements, assure positive blowout protection while tubing is being run, well washed, packer collapsed, tubing suspended, etc. In fact, the highest pressure wells may, with absolute safety, be washed completely clean with water or oil before hanging the tubing.

They provide four proven methods of suspending and sealing the tubing string: (1) Ram suspension on a hanger nipple as illustrated above; (2) Slip suspension in the top flange of the head, utilizing the rams as a master gate below the outlets to seal the annular space between tubing and oil string; (3) Boll-weevil suspension from the top flange of the head; (4) Suspension from a threaded hanger flange which bolts down on top of the head.

They are extremely practical on any reworking subsequent to the original completion of the well. When used in conjunction with a second Cameron ram-type control unit, tubing may be raised or lowered, or pulled from the well under pressure without killing and without disassembling the tree.

They obviate the need for a cement retainer when making a squeeze job.

## CAMERON IRON WORKS, INC.

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Member Association of Well Head Equipment Manufacturers

# Refinery Applications of Rotary Pumps

PETROLEUM ENGINEER Exclusive Feature

*PART 2 (Concluded)*

*by R. G. Lovell*

Development Engineer, Hancock Oil Company of California

## Rotary Piston Displacement Pump

FOR many refinery duties close and convenient control of the volume discharged by a pump, either at the pump itself or at some remote point, has several marked operating advantages. With the conventional rotary displacement pump this was difficult, involving as it did some sort of variable-speed device between driver and pump, steam-turbine drive, or relief valve bypassing to suction at some predetermined pressure. None of these methods was altogether satisfactory, and recourse was usually had to a centrifugal pump. For some refinery pumping jobs a centrifugal pump does not meet all the requirements as well as does the rotary displacement pump and, in any case, to throttle the centrifugal discharge offers certain mechanical difficulties and is wasteful of power.

A few years ago a large eastern manufacturer, one of the oldest in America, but one who had never before made pumps of any kind, developed a rotary pump that offers this desirable variable volume control feature. The design of this unit consists of a housing, rotor, piston, and shuttle block, as shown in an accompanying illustration. (Fig. 6.) The rotor is concentric with the shaft and is a liquid-tight fit in the housing. The square slot across the face of the rotor forms a double-end square cylinder in which the corresponding square piston operates. The piston, which is in the form of a channel, receives the shuttle block, which has a hole in its center forming a bearing operating on an offset pin mounted in the cover. When the rotor revolves, the offset relation of the pin to the rotor shaft imparts a reciprocating motion to both the piston and the shuttle block. This gives the pump a rotary piston displacement action. The two openings through the side of the rotor are the ports for the liquid pumped by the shuttle block. It will be observed that there are four pumping strokes per revolution, thus contributing to a smooth discharge flow.

This type of pump, in its simplest form, is equipped with an integral dashpot relief valve that allows the discharge to be throttled from full to zero without shock to the pump. The dashpot design of relief valve, integral with the pump, is now used on several of the better-known rotary pumps and is found to be more satisfactory in operation, as by this construction the relief passage is linked from the suction port of the pump directly to its discharge port. This permits a full flow of the liquid through a separate passage from one chamber to the other and apart from the body cavity containing the pumping members.

## Variable Volume Control

The spring-loaded relief valve, no matter how well designed, still left this pump somewhat short of the desired objective. The next step in increasing the efficiency of the unit was a device for attaining variable volume control automatically and to any desired point between complete shut-off and full capacity. This device varies the volumetric capacity of the pump to the amount of liquid directed through the discharge ports, in direct proportion to the eccentricity of the shuttle pin, from full to zero capacity. Study of the accompanying drawing (Fig. 7) will make clear how this is accomplished better than any number of words could do. The variable volume control head eliminates the bypass and, consequently, there is no heat generated by passing the liquid through its necessarily restricted area. This is of particular pertinence when pumping gasoline or other volatile fractions. The mechanical efficiency of the pump is also improved for the same reason.

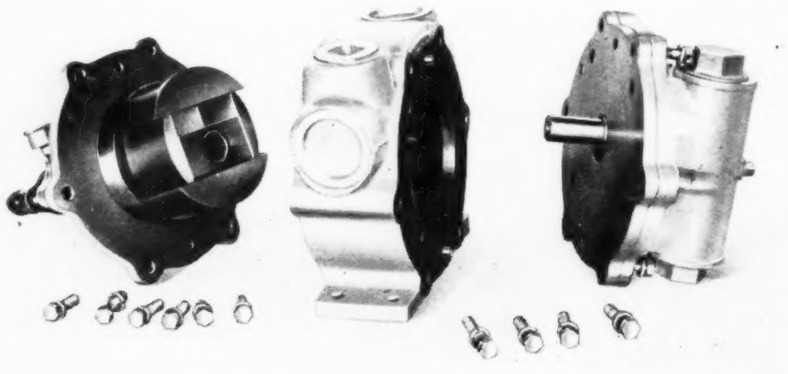
## Manual Flow Control

Control of flow by limiting maximum as a function of discharge line pressure is adequate if the unit is used as a transfer pump, but lacks the necessary accuracy and flexibility of control to make it suitable for that which seems to be its greatest field of usefulness, that is, for continuous blending operations.

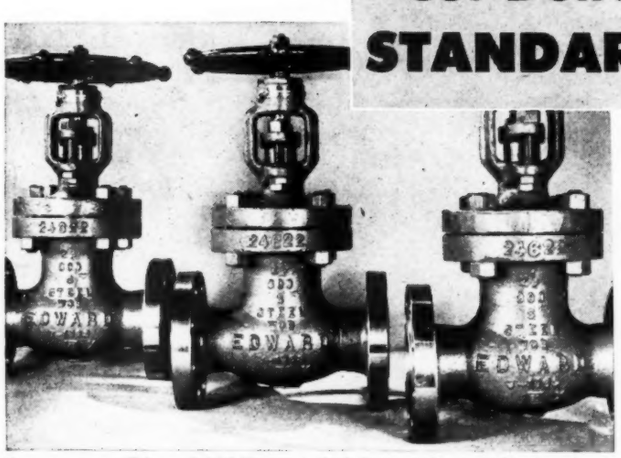
To satisfy these requirements necessitates only the substitution of positive and manual control of the stroke length for the adjustable tension spring control. This permits the operator to adjust the delivery to the needs of each pumping operation from zero to maximum capacity without increasing the discharge pressure, but still allowing the variable volume control to operate automatically when required. (Fig. 8.)

The value of this feature will be obvious to refinery men, but it is pertinent to point out some specific instances. To have the volume of the liquid to be heated in an exchanger under close and easily manipulated control according to processing requirements, is certainly of marked advantage. Or to blend motor or aviation gasoline to volatility or other specifications as delivered to transport equipment is much to be desired, particularly for rea-

*Fig. 6. Rotary piston displacement pump*



# Cut Delivery Time with These STANDARD EDWARD VALVES



It pays to use Edward 300 lb sp steel globe, angle and check valves. Note strong, functional design of 2½ in. cast steel globe stop valves above. Fully guided disk permits installation in any position.

**Choosing these standard Edward valves means quicker delivery. But important as that is today, there are other big dividends—such things as maximum job and part interchangeability, easier installation and other time saving factors.**

**Built with the customary Edward emphasis on "plus value" construction, these versatile forged and cast steel valves fit a wide variety of power, petroleum, process piping and industrial services. For more detailed descriptions and dimensions see Edward Catalog No. 101. If you haven't a copy, a post card will bring you one by return mail.**

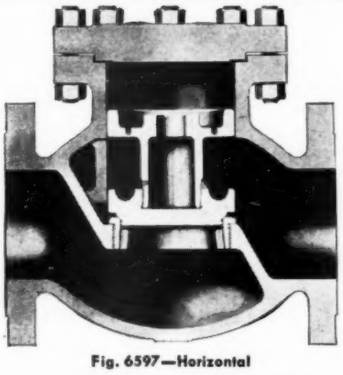


Fig. 6597—Horizontal

## CAST STEEL CHECKS . .

For 300 lb check valve service, choose Edward Fig. 6597 (horizontal) or Fig. 6598 (angle). Cast steel, piston type, flanged ends, sizes 2½ in. to 12 in. Integrally cast ribs guide disk-piston assembly throughout travel. Streamlined bodies contoured for free flow. Also built for pressures to 1500 lb and in sizes to 12 in. Forged steel check valves, ¼ in. to 2 in. available.

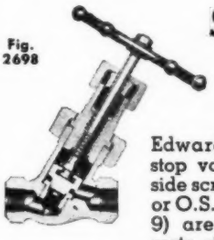


Fig. 2698

## SCREWED STOP VALVES

Edward screwed end stop valves, either inside screw (Fig. 2698-9) or O.S. & Y. (Fig. 2688-9) are going into all sorts of service today. Full area forged steel bodies minimize pressure drop. EValloy seats and disks. Drop tight closure. Globe and angle, for 600 lb sp in sizes ¼ in. to 2 in.

## FLANGED STOP VALVES . .

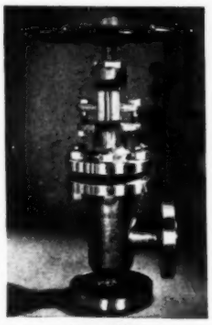
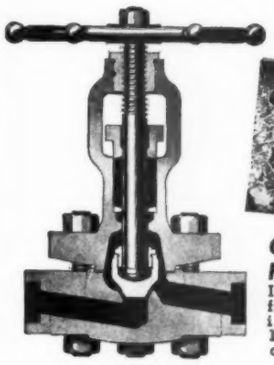
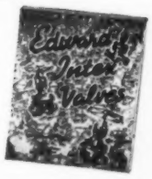


Fig. 4829

There's long, economical life in Edward globe and angle forged steel flanged end stop valves. Seats, disks and stems are EValloy, Edward's specially processed stainless steel. Unique swivel plug type disk design prevents galling. Heat treated forged steel bodies proportioned to reduce distortion under heat. O.S. & Y. with bolted bonnets and bolted glands. For pressures to 600 lb sp, sizes ½ in. to 2 in. Same design characteristics available in valves for service to 1500 lb.

## INTEX GLOBE STOP VALVES . .





**GET THIS FOLDER!**

Intex valves are fully described in Catalog 12-G5. Write for a copy today!

Fig. 3264

Disks and integral seats of these Edward Intex valves are hard surfaced with Stellite. Disassembly unusually easy, working parts readily accessible. Socket welding, flanged or screwed ends for pressures to 1500 lb at 950 F.

## BLOW-OFF VALVES . . . .

Edward blow-off valves are designed to avoid damaging shock to piping. Simple, frill-free construction with no unnecessary parts to erode or cause clogging. EValloy and Stellite seats and disks. Globe type seating for tight closure. Straightway and angle for 150 to 1500 lb sp service.

**THE EDWARD VALVE & MFG. CO., INC.**
**1592 WEST 145th STREET • EAST CHICAGO, INDIANA**

# EDWARD Steel CAST AND FORGED VALVES

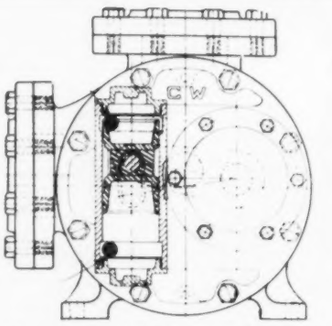


*Fig. 7. Variable control head*

sons of reduction of evaporative losses. The manual volume control of this pump can be made with extreme accuracy, where required, by use of a closely calibrated, so-called "micrometer" head, as illustrated. (Fig. 9.) The writer has found this refinement to be of distinct value in the blending of lubricating oil stocks, not only because of its accuracy, but, secondarily, because the completed blend required no heating to obtain satisfactory uniformity of specific gravity. Heating of lube stocks accelerates oxidation, which lowers the quality of the oil.

### Cam and Piston Type

The reader will recollect that, in a preceding article, it was established that the fundamental point of superiority of a rotary pump was that it offered the advantages of a positive displacement pump but with lesser weight than a reciprocating pump. Lesser weight, accomplished by higher speed, meant higher liquid velocity within the pump, which introduced difficulties with high viscosity or with volatile liquids, and robbed the rotary of some of its advantages of its valveless construction.

To overcome this handicap is the objective of the cam-and-piston, or rotary plunger type pump illustrated in Fig. 10. The pump consists essentially of a cylinder casting, divided vertically to make two chambers, with suction and discharge openings converging into common pipe connections; removable cylinder heads carrying the bearings; one driveshaft upon which are mounted two cams or eccentrics set 180 deg. apart, and separated from each other by the center wall between the two pump chambers, each eccentric, in turn, actuating a plunger having a hollow arm that slides freely in a slide pin. The driveshaft extends through a single stuffing box for connection to motive power.

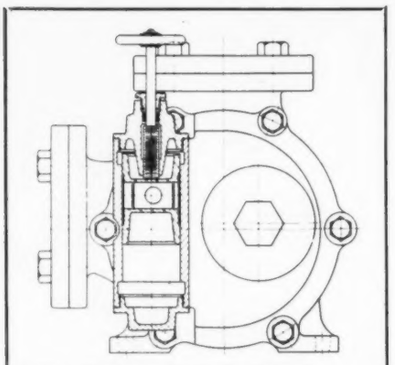


*Fig. 8. Positive and manual control of stroke length is here substituted for adjustable tension spring control*

Holes drilled through the plunger carry the liquid being pumped to the cams under pressure. The bearings are lubricated by this liquid, which then returns to the suction side of the pump through return piping that, on the open head, is connected adjacent to the stuffing box. This reduces the stuffing box pressure and lessens the duty on the packing. The pistons do not operate in direct tangential contact with the cylinder bore. In analyzing this design of rotary pump for its lubrication facilities the reader should note that the friction between the piston surfaces and the cylinder bore is almost entirely an internal rolling friction between adjacent particles or layers of the pumpage. This is also true of the bearing surfaces of the eccentrics. Anyone who has had experience with eccentric drives on steam engine valve motions will remember that the eccentrics require a minimum of lubrication. The rocker in which the slide valve operates is under balanced pressure as well as the valve surfaces and, consequently, offers few lubrication difficulties.

The rotating plunger pump is extensively used as a vacuum pump in asphalt and lubricating oil refining. When so used the chief modification is in providing direct contact between the piston and the bore. As the pressures involved are necessarily low and limited to barometer, no lubricating difficulties are caused by this mechanical contact.

### All-Purpose Rotary Pump

Most of the pumps thus far described are designed to fit specialized pumping problems, but because they are so designed, they are necessarily lacking in the range of duties that they can perform satisfactorily. There are many uses in an oil refinery for which a rotary pump is well suited, however, but the requirements are often such that they do not come within the capabilities of these special designs. For such conditions the helical gear type illustrated in Fig. 11 is to be recommended. The helical gear type of rotor construction provides a longer time interval for the liquid to enter and be discharged from the rotor recesses, thus eliminating the possibility of hammer and permitting operation of large capacity units at higher speeds. It further increases the top range of viscosity of liquid that can be handled successfully by the rotary pump. The rotor gears are capable of withstanding a greater total discharge pressure, as the TDH is divided into a greater number of units of length of surface.

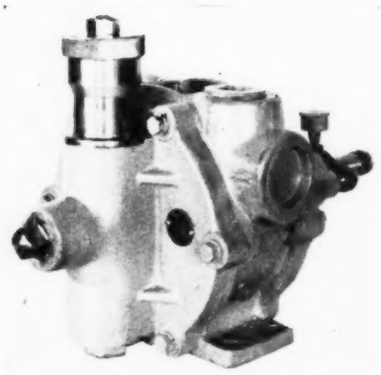


*Fig. 9. Manual volume control of pump can be made with extreme accuracy by use of a "micrometer" head*

The driving load, in the more advanced designs, is separated entirely from the displacement gears and is carried by timing gears that are usually made of high-grade, alloyed steel and provided with their own lubrication system, separate from the pumpage. For handling liquids with no lubricating value, or when abrasive materials might be present, some helical gear pumps are so constructed that the roller and thrust bearings are included in the timing gear lubrication system.

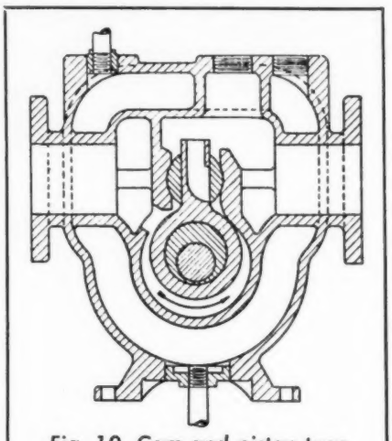


*Fig. 10. Cam and piston type rotary pump*

# Hanlon-Buchanan, Inc

## PIONEER NATURAL GASOLINE MANUFACTURER

EXPORT TERMINALS:
Goodhope, La. Corpus Christi, Tex.
Houston, Texas Texas City, Texas
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TULSA, OKLAHOMA
NATIONAL BANK OF TULSA BUILDING
PHONE 4-1101 or L. D. 398 WIRE — OR WRITE P. O. BOX 1559
Cable Address STAVOLENE, Tulsa, U. S. A.

FOREIGN REPRESENTATIVE:
Barnes, Williams & Co., Ltd.
4 Lloyd's Ave.
London, England

To aid in calculating hydraulic loads, particularly for liquids of considerable viscosity, a table is shown that has incorporated in it values for oils of different viscosities and by different viscosity scales. (See table P 615.200. in the Continuous Tables Section, page 159, October issue.) This table is especially useful inasmuch as it includes the values to be given for 90-deg. standard pipe elbows.

All types of rotary pumps have not been covered in this article, but certain representative types have been used as examples and within ethical limits every endeavor has been made to treat fairly each type.

Acknowledgment is made to the Hydraulic Institute for supplying drawings representative of the various types of pumps.

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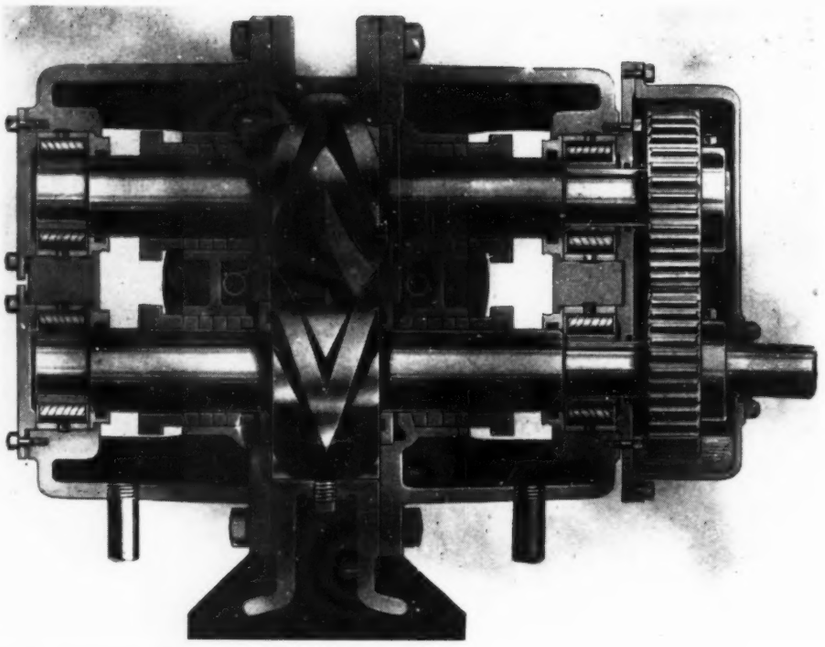

*Fig. 11. Helical gear type—an all-purpose rotary pump*

P 533.5

# Influence of Gas-Oil Ratios and Water Saturation on Productivity

WHEN nations throughout the world are pitted against each other in a war in which petroleum plays a major role, scientists and engineers of the petroleum industry must give serious thought to ways and means for recovering greater percentages of oil from natural reservoirs than in the past. Petroleum and its products are vital to highly mechanized modern warfare, and the victorious nations will be those whose armed forces are supplied with adequate fuel oil, gasoline, and lubricants.

Efficient recovery of oil from underground reservoirs depends on many interrelated techniques; evaluation of the producing performance of wells upon the basis of their productivity indexes is one such tool. Oil wells usually yield oil at a maximum rate when first brought-in. The rate of production begins to decline soon after the first oil is delivered to the tanks, and although part of the decline usually can be attributed to natural reduction of reservoir pressure as oil and gas are withdrawn from the reservoir, a larger proportion frequently is caused by greater saturation of water and gas in the producing formation about wells and clogging of the pores of the sands by silt, organic salts, and insoluble hydrocarbons. If the maximum quantity of oil is to be recovered from reservoir sands and rocks by wells, it is then imperative that the ability of wells to produce oil be watched closely and all adverse influences that affect the ease with which oil can flow to wells be corrected.

U. S. Bureau of Mines Report of Investigations 3657, "Productivity of Oil Wells and Inherent Influence of Gas-Oil Ratios and Water Saturation," by R. V. Higgins, presents the results of a study of the influence of gas-oil ratios and water saturation on the decline in productivity indexes of oil wells; the changes occurring in gas-oil ratios and water saturation in the sand surrounding the well over long periods are discussed and their influence analyzed; and it is shown that the application of field data and their correlation with the evaluation of well performance will assist petroleum engineers to obtain maximum recovery of oil from underground reservoirs.

The report contains a graph showing a correlation between gas-oil ratios, water saturation, and relative permeability of oil-producing sands, which should prove helpful to petroleum engineers analyzing the producing performances of wells. Equations also are given by means of which the initial productivity index of a well can be estimated when the average water saturation in the sands about a well and their permeability are known, and these equations can be used to determine the efficiency of well-completion methods.

As many essential well-performance data often are lacking, and it is impossible to analyze completely the producing behavior of wells by means heretofore used, the writer has developed a ratio method (discussed in the report) that gives satisfactory results with minimum field data. The ratio method makes it possible to use productivity indexes to determine whether (1) water entering a well is coming from a part of the formation that might be plugged-off without decreasing the oil-producing capacity of the well; (2) gas flowing from a high gas-oil ratio well is largely from the gas cap or a gas sand that might be cemented-off, and (3) after a well has produced oil for a year or more, the face of the producing sand exposed to the well has become clogged by water, silt, salts, or semisolid hydrocarbons.

A number of numerical examples are given in the report, which show that (1) extensive changes in the distance of the pressure source from wells have minor influence on productivity indexes; (2) the diameter of wells has a material influence on their ability to yield oil, and (3) the evaporation of some of the interstitial water as a result of differences between the partial pressures in the immediate vicinity of wells and back in the formation may increase their productivity.

A discussion of one-, two-, and three-phase flow through reservoir sands also is included because of its bearing on productivity indexes.

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P 071.

# PATENTS AND THE PETROLEUM INDUSTRY

PETROLEUM is one of the basic industries whose progress has been accelerated in substantial measure by the adoption and prudent application of patented inventions and processes. These inventions and processes are the brain-children of inventors and researchers, many of whom are field or plant workers who lean heavily on the beneficent provisions of the American patent system for the proper protection and exploitation of their brain-children. To a much greater extent than is realized, many of the daily operations performed in the various branches of the oil industry owe their adoption to the development of one or more patented inventions or processes. In a very real sense, research on new processes and new inventions are the very roots from which true progress in the oil industry stems.

A knowledge of the patent system and how it functions is therefore of pertinent interest at this time when, during the stress of war, far-reaching changes in the patent system are being advocated.

Much of the mystery that surrounds the patent system and its functions, so far as the layman is concerned, arises from the paucity of information that is available on the practical aspects of the patent system.

Following suggestions from readers, it is planned to publish a series of articles covering various phases of this important subject. The four articles in this section are the first of the series. Practical considerations involving patent rights and the exploitation of patented inventions as they pertain to the petroleum industry will be so presented that the average reader should acquire for his own needs an intelligent understanding and appraisal of the American patent system.

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## The American Patent System[1]

*by Hon. Wallace H. White, Jr.*
Senator from Maine

IT IS my purpose to talk about the patent situation in the United States, and some of the legislative proposals which are now pending before the Senate Committee on Patents.

Mr. President, the Committee on Patents of the Senate has been engaged from April 13 to May 22, 1942, inclusive, with hearings on two measures, S. 2303 and S. 2491, introduced respectively February 23 and March 30, 1942, and both sponsored by Senators O'Mahoney, Bone, and La Follette.

The hearings have been conducted under the authority of Senate Resolution 40, agreed to January 14, 1941, and authorizing—

> The Committee on Patents, or any sub-committee thereof * * * during the Seventy-seventh Congress to send for persons, books, and papers, to administer oaths, and to employ a stenographer, at a cost not exceeding 25 cents per hundred words, to report such hearings as may be had in connection with any subject which may be before said committee, etc.

While various amendments to the patent law have been under consideration in both House and Senate during the past few years, the principles and policies of the pending bills find their genesis, I believe, in the final recommendations of the majority members of the T. N. E. C., in the views of the Department of Justice, and in Monograph No. 31 of the T. N. E. C., entitled "Patents and Free Enterprise."

I regard it as appropriate to bring to the notice of the Senate that for the further study of our patent system the President by Executive order of December 12, 1941, established the National Patent Planning Commission, to which he appointed as the five members thereof Dr. Charles Kettering, chairman; Owen D. Young; Chester C. Davis; Edward F. McGrady; and Dr. Francis P. Gaines, president of Washington and Lee University. The purpose of this Commission is stated in the second paragraph of this order, which reads as follows:

[1]This address was delivered in the United States Senate June 29, 1942, and is reprinted from the *Congressional Record* because of its highly informative value in covering comprehensively the American Patent System.

2. The Commission is authorized, in conjunction with the Department of Commerce, to conduct a comprehensive survey and study of the American patent system, and consider whether the system now provides the maximum service in stimulating the inventive genius of our people in evolving inventions and in furthering their prompt utilization for the public good; whether our patent system should perform a more active function in inventive development; whether there are obstructions in our existing system of patent laws, and if so, how they can be eliminated; to what extent the Government should go in stimulating inventive effort in normal times; and what methods and plans might be developed to promote inventions and discoveries which will increase commerce, provide employment, and fully utilize expanded defense industrial facilities during normal times.

This Commission is to report the result of its studies and recommendations to the President.

Opening the hearing on S. 2303 the chairman of the committee, the senior Senator from Washington, Senator Bone, declared:

This is not a patent reform bill; this is really a war bill (p. 7).

The senior Senator from Wyoming, Senator O'Mahoney, following, stated:

Before this bill was introduced I had the privilege of discussing its terms with him (the chairman) and with the staff of the Department of Justice. * * * Its operation is limited to the time of war (p. 8).

It is apparent that this limitation, however it applied to S. 2303, has been abandoned in the second measure, S. 2491.

Let me now analyze briefly S. 2303. This measure is entitled:

A bill to provide for the use of patents in the interest of national defense or the prosecution of war, and for other purposes.

Its purpose was made clearer by the explanation of Mr. Francis Shea, Assistant Attorney General, who, I understand aided in drafting the measure, and who alone, among the many representatives of the Department of Justice appearing before the Patent Committee, discussed its terms. He explained that section 1 would authorize the President during any war in which the United States may be engaged—

To find and declare that the manufacture, use, or sale of any material, article, product, or commodity, or that the expansion of facilities or capacity therefor is in the interest of national defense or of the prosecution of war.

He maintained that two results would follow such a finding and declaration. He stated them as follows:

(a) The President may grant licenses authorizing the use of any patented inventions relating to such manufacture, use, or sale, prescribing in such licenses the terms and duration thereof, and a reasonable royalty to be paid by the licensee to the patent owner. The patent owner's sole remedy against the licensee will be the royalty fixed in the President's license.

(b) Whether or not licenses are issued under section 1 (a), the owners of patents infringed by any manufacture, use, or sale specified in the President's declaration will no longer be entitled, during the period specified by the President, either to an injunction against such infringements or to treble damages therefor. The patent owner's sole remedy will be the recovery of a reasonable royalty fee from the infringers for the period in question.

These dual effects of the President's finding and declaration may operate independently or together. The President may declare, for example, that the manufacture of magnesium is in the interest of the prosecution of the war for the duration, but may choose to issue no specific licenses thereunder. The declaration will have the effect of a general license to whoever desires to use any patents relating to the manufacture of magnesium, whether or not he or anyone else holds a specific license from the President under those patents. The patent owner will be precluded for the duration of the war from obtaining an injunction against infringement of his patent by such manufacture, and from recovering treble damages on account of the infringement. The exclusive remedy of the patent owner will be the recovery of a reasonable royalty from the infringer, which may either be agreed upon by the parties or fixed by a court.

A study of the bill makes clear to me:

First. That the license issued by the President under its authority is not exclusive. Anyone may manufacture, use, or sell under any patent covering the materials or commodities which are the subject of the President's finding and declaration.

Second. That the only difference between anyone operating under a Presidential license and one engaged in unlicensed operation is that the President fixes the royalty without judicial appeal in the first instance, and in the second the patent owner's only remedy is the recovery of a reasonable royalty through an action for infringement in a Federal court.

Third. That in neither case does the United States assume any liability for recovery of just compensation for the use of the patent property infringed. The section in effect licenses infringers by condemnation of the owner's vested right in his patent without assuring just compensation.

The second effect is to invite general infringement of all patents covering the affected articles and leaving the patent owner to identify infringers and secure "fair" compensation from them subject to all known defenses.

Fourth. That the President fixes the duration of any license issued and is not limited in such fixation by the war. On the contrary, it was made plain that, in the opinion of Mr. Shea and of some members of the committee, it would be essential that such licenses extend over a considerable period of years in order to assure acceptance by investors of the risks involved.

While the first section of the bill deals exclusively with licenses, the second section authorizes "in the interest of national defense" not only during time of war but during "any period of national emergency" declared by the President to exist that he, the President, may acquire patents, applications therefor, inventions, or licenses by donation, purchase, or taking, and in turn issue licenses thereunder.

The Commissioner of Patents is required to mail a notice of taking to the last owner of record and publication of the same in the Official Gazette. The owner thereupon is paid nothing, but may bring suit in the Court of Claims for fair compensation, the United States availing itself of all known defenses.

The President may exercise these powers under appropriate regulations through any department, agency, or officer.

Mr. Shea made it plain that he employed the term "fair" compensation instead of "just" as "there may be some doubt whether patents are the kind of property included within the constitutional requirement for just compensation." The chairman, the Senator from Washington [Mr. Bone], made it equally clear that he shared that view:

My opinion has always been that a patent right is more in the nature of a franchise or a license than a vested property right (p. 1258).

Assistant Attorney General Arnold agreed, saying:

I think your statement is correct.

The statements of Mr. Shea with respect to Senate bill 2303 were directed to section 2, involving the exercise of the power of eminent domain—in this instance the taking of a patent. One who speaks for the Department of Justice is peculiarly the voice of the law. But here at the outset of a discussion of patents an Assistant Attorney General of the United States, for the first time in our history, repeatedly expresses doubt, and invites Congress to express by legislation a similar doubt as to whether patents are property and whether either seizing them or authorizing their use without the owner's consent requires compensation. Mr. Shea, under interrogation, re-emphasizes this view, again referring to "fair" compensation:

I think it could clearly be interpreted as just compensation if it constituted the taking of property. On the other hand, there may be some doubt as to whether or not patents are the kind of property included within the constitutional requirement for just compensation. If it is not a taking of property within the fifth amendment, then the patent owner will receive such compensation as the courts deem fair. This does not intend to express congressional opinion as to whether or not it is a taking within the meaning of the Constitution (82).

The issue is whether or not it is a franchise or whether or not it is a license granted under such conditions by the Constitution (83).

I direct attention to the fact that under section 2, if the President takes a patent under the conditions stated he not only offers no compensation, as is

the case in all other forms of the exercise of eminent domain, but by the seizure he excludes the patent owner from the use of his own patent during the period in which he seeks compensation by suit against the United States.

If it is the use of patents by the United States for the prosecution of the war that is necessary, section 2 of the bill could be eliminated and the President empowered to authorize any person to manufacture, use, or sell commodities found necessary during the period of the war; and, having thus thrown patents into the public domain, he could prescribe a reasonable royalty subject to judicial review, as is now the case in the requisitioning of all other property. So far as I know, in all other cases in which the United States takes or uses property or authorizes its use, it assumes obligation for just compensation. This would be the simple approach and the practical one. But this would not meet the requirements of a theory that patents are not property and may be taken without compensation; for if they are not property there can be no compulsion to give compensation. It is therefore vital to determine whether Mr. Shea declares the law as it is or whether he does not; for in my opinion the whole structure of both bills under consideration and all the theories upon which pending recommendations are based, measures are being drafted, and hearings are proceeding, ignore the present state of the law.

Let us next consider Senate bill 2491, introduced by Senators Bone, O'Mahoney, and La Follette on April 28 after hearings on Senate bill 2303 had been under way since April 13. The former measure, Senate bill 2303, by its title, its sponsors' declared intention, and its major terms, is confined "to any war in which the United States may be engaged." The application of any of its terms beyond such period exceeds the declared intention of its proponents, or is incidental to its operation, or is the result of poor draftsmanship.

But Senate bill 2491 is avowedly permanent legislation with a revolutionary effect upon the patent system. All patents issued after its enactment become subject to the following restrictions:

(a) The Commissioner of Patents may, upon his own initiative or complaint, investigate and determine whether a patent owner fails for three or more years to make, use, or sell a patented invention, or license the same for reasonable compensation, whether such action violates the Antitrust Act or is without reasonable justification. An adverse decision authorizes the Commissioner to license subject to review.

(b) No patent shall authorize selling, assigning, or licensing which imposes any restriction as to the quantity or value which machines may produce, the price at which a patented product may be sold, the purpose for which it may be used, or any limitation of the geographical area within which the patented article may be produced, sold, or used.

(c) Ninety days after the enactment of the proposed measure its terms shall retroactively apply to all restrictions, agreements, or understandings in effect with respect to preexisting patents.

(d) The United States may bring an action in any district court for a violation of (b) or (c) before a judge without a jury. If sustained, a decree may thereafter be issued canceling the patent or the limited rights, if any, of the defendant. The patent is extinguished save for a reversal on appeal.

(e) All sales, assignments, or other conveyance of preexisting or new patents, and all licenses or other agreements thereunder, must be in writing and filed with the Federal Trade Commission within 30 days after execution by the seller, assignor, or grantor.

Such file is public and copy therefrom may be had on payment of a reasonable fixed fee. There is a penalty of $1,000, and $10 for each additional day for failure to comply.

(f) Infringement suits against sellers or users of patented articles are prohibited unless the complainant first gets a decree against the manufacturer or supplier sustaining the validity of the patent. Suits for contributory infringement are likewise prohibited unless the complainant is an assignor or vendor and has first obtained a decree against the primary infringer.

(g) It would be made unlawful to convey any patent or interest therein in any manner or grant any license which, through any condition, agreement, or understanding would tend substantially to lessen competition or grant a monopoly "unless such restriction is necessary to promote science or the useful arts."

(h) The Commissioner of Patents and the Federal Trade Commission are given authority to conduct investigations, assure attendance of witnesses and the production of books, records, and documents, with the aid of the district courts.

Incidentally, the counsel of the Federal Trade Commission submitted a proposal similar in terms but more drastic in penalties, to be administered exclusively by the Commission.

At no time during the hearings was this second measure — S. 2491 — analyzed as was S. 2303 by Assistant Attorney General Shea. It was the subject of only incidental reference. It proposes:

First. Permanent compulsory licensing.

Second. Unrestricted licensing.

Third. It would not only affect patents issued after its enactment, but retroactively operate upon all patents heretofore issued, and all rights which have vested in them or arrangements made under them.

Fourth. It ambiguously amends the Antitrust Act, authorizing penal prosecution without a jury.

Of compulsory licensing, it may be said that it has been proposed many times and was a special subject of discussion during extended hearings by the House Committee on Patents in the last Congress. The proposal was abandoned after extensive discussion, finding no substantial support.

Of unrestricted licensing, it may be said that without exception the courts of the United States and the Congress have recognized uniformly and repeatedly that various restrictions are "reasonably within the reward which the patentee by the grant of the patent is entitled to secure." Assistant Attorney General Arnold, with equal uniformity and unique consistency, has steadily insisted that that is not the law. He has with equal emphasis, as have some legislators, disregarded the fact that within limits a patent is a constitutionally authorized monopoly, the limits of which are clearly fixed and within which the patent owner is clearly entitled to assert rights which are equally sharply condemned whenever they are exceeded. The failure to recognize this condition is the cause of much confusion in the discussion of this whole subject.

Under the patent law a patentee is given by statute a monopoly of making, using, and selling the patented article (Chief Justice Taft, *U. S. v. General Electric*, 272 U. S. 485).

The present Chief Justice for the Court declared in 1940:

The patent law confers on the patentee a limited monopoly. The right or power to exclude all others from manufacturing, using, or selling his invention. * * * He may grant licenses to make, use, or vend restricted in point of space or time or with any other restriction upon the exercise of the granted privilege, save only that by attaching a condition to his license he may not enlarge his monopoly and thus acquire some other which the statute or the patent together did not give (*Ethyl Gas Corporation* v. *United States*, 309 U. S. 436).

On May 11, 1942, the Chief Justice again spoke for the Court, saying:

The declared purpose of the patent law is to promote the progress of science and the useful arts by granting the inventor a limited monopoly, the exercise of which will enable him to secure the financial rewards for his invention. The full extent of the monopoly is the patentee's "exclusive right to make, use, or vend the invention or discovery" (*United States* v. *Univis Lens Company*).

Of course, a patent is a monopoly. It

is made one by law for the purposes stated by the Court. But it is limited monopoly and cannot be used beyond its terms. This is just as clear as the nature of the patent itself.

### Patents and the Antitrust Act

Patents, like any other property, may be and have been used to violate the Antitrust Act. The courts have recognized that fact and have clearly reinforced the Government's remedies to meet that condition by broad interpretation of the law. The patent owner, it is true, restrains competition because it is necessary to obtain a license from him by which he waives his limited monopoly in return for a financial reward for the use of his invention. When he grants the use of it for a limited time or within a limited territory he is doing nothing different from what a property owner does who limits the length of his lease for that part of his land which may be occupied by another. When he does these things he is on an equality with other property owners in general, but he cannot enter into private agreements with others by which he relates his property to theirs either to use it for unlawful purposes or unreasonably to restrain trade or assist in the creation of some other monopoly forbidden by law.

There is nothing new about that. More than 80 years ago Chief Justice Taney declared that when a patented article—

passes to the hands of the purchaser, it is no longer within the limits of the monopoly, it passes outside of it and is no longer under the protection of the act of Congress (*Bloomer* v. *McQuewen*, 14 How. 539).

So all attempts upon the part of copyright or patent owners to fix the resale price of their product or on the part of the latter to compel the use of materials essential to the working of a patented machine but not covered by the patent, have all been defeated. In every form in which the improper extension of the limited patent monopoly has been attempted it has been defeated. *Bobbs Merrill Co.* v. *Straus* (210 U. S. 339); *Dr. Miles Medical Co.* v. *Parke and Sons* (220 U. S. 373); *Henry* v. *Dick Co.* (224 U. S. 1); *Boston Store* v. *American Gramophone Co.* (246 U. S. 8).

It is well settled that where the patentee makes the patented article and sells it he can exercise no future control over what the purchaser may wish to do with the article after his purchase (*Mr. Justice Taft, U. S.* v. *Gen. Electric*, 272 U. S. 489).

Referring in the same opinion to the patent owner's rights and discussing them as distinct from his offenses, he points out exactly how the patent owner violates the Antitrust Act:

It is only when he adopts a combination with others by which he steps out of the scope of his patent rights and seeks to control and restrain those to whom he has sold his patented articles in their subsequent disposition of what is theirs, that he comes within the operation of the Antitrust Act (idem).

So, too, in the latest expressions of the Supreme Court we find the distinction between the rights and wrongs of patent owners restated with reference to all the older cases.

The public policy which includes inventions within the granted monopoly excludes from it all that is not embraced in the invention. It equally forbids the use of the patent to secure an exclusive right or limited monopoly not granted by the Patent Office, and which it is contrary to the public policy to grant (*Morton Salt Co.* v. *Suppiger Co.*, January 5, 1942).

So, too, in its latest decisions the Court looks through a selling agreement where, under color of a patent, the selling facilities of competitors are employed, and finds a price-fixing combination in an effort to control sales prices under the color of agency, and points out:

If it were sanctioned in this situation, it would permit the patentee to add to his domain at public expense by obtaining command over a competitor. He would then not only secure a reward for his invention; he would enhance the value of his own trade position by eliminating or impairing competition. That would be no more permissible than a contract between a copyright owner and one who has no copyright, or a contract between two copyright owners or patentees, to restrain the competitive distribution of the copyrighted or patented articles in the open market (*U. S.* v. *Masonite Corporation*, May 11, 1942).

So, too, a lens company controlling the patent in a refracting lens cannot fix the resale price of the blanks which express its patent and which it sells to another who, after buying them, finishes the lens to fit a particular pair of eyes. The patent monopoly could not extend to a new and finished article represented by the individual lens (*U. S.* v. *Univis Lens Co.*).

Both the preceding cases limit the patent monopoly and subordinate it to the Antitrust Act whenever the patent is used to establish restraining agreements between persons or competitors with respect to the conduct of their business which is outside the patent itself.

I come now to the question, What is a patent? There seems to me to be much confusion of mind as to the rights accorded a patentee by the patent he takes out, and as to the limitations of law upon these rights.

### What Is a Patent?

It is a public instrument given to an inventor or author, securing to him, under the constitutional grant of Congress, the exclusive right to his discoveries. It is the means constitutionally provided by which Congress is directed—

to promote the progress of science and the useful arts by securing for limited times to * * * inventors the exclusive right of their * * * discoveries.

The patent does not give the right to manufacture, use, or sell. Everyone had that right before the Constitution. What a patent does is to give the right to exclude others from making, selling, or using an invention without the inventor's permission. One can be an inventor without having a patent, but he cannot get a patent without being an inventor. For to get the patent he must make public disclosure of the subject matter of the invention, and at the expiration of the limited period—17 years—for which his exclusive right continues, his invention becomes public property. Indeed, during that time it is open to anyone in the world to improve it, perhaps so effectively that the original patented invention is commercially worthless without the improvement.

Early in our judicial history Chief Justice Marshall described a patent:

It is the reward stipulated for the advantages derived by the public for the exertions of the individual, and is intended as a stimulus to those exertions. * * * The public yields nothing which it has not agreed to yield; it receives all which it has contracted to receive. The full benefit of the discovery, after its enjoyment by the discover for 14 (now 17) years, is preserved; and for his exclusive enjoyment of it during that time the public faith is pledged (6 Peters 217, 241-2).

A license to use a patent is nothing but a waiver by the owner of his right to exclude others from making use of that which is his. Nor are the legitimate restrictions placed in licenses as to time, space, or other limitation modern innovations, as is suggested by the author of monograph No. 31, Patents and Private Enterprise. They are as old as the patent system. One hundred years ago, when Goodyear was discovering the uses of rubber, he was issuing licenses limited, for example, to civilian clothing, and excluding Army or Navy equipment and limiting the production to a particular establishment and nowhere else. Such a license was sustained by the Supreme Court of the United States (*Goodyear v. Providence*, 9 Wall. 788). Furthermore, similar limitations have been recognized up to the last decision of the present Supreme Court of the United States.

The present Chief Justice of the United States expressed the unanimous opinion of the Court in 1940 when he said:

The patent law confers on the patentee a limited monopoly. The right or power to exclude all others from manufacturing, using, or selling his invention. * * * He may grant licenses to make, use, or vend, restricted in point of space or time or with any other restriction upon the exercise of the granted privilege, save only that by attaching a condition to his license he may not enlarge his monopoly and thus acquire some other which the statute or the patent together did not give (Ethyl Gas Corp. et al. v. U. S., 309 U. S. 436).

The most recent word of the Supreme Court from the lips of the same

justice reasserts the same principles in determining the point at which the recognized patent monopoly ends and the control of the patent owner ceases (*United States v. Univis Lens Co. et al.*, May 11, 1942).

## Is the Patent Property?

Are the rights of the patent owner privileges which may be withdrawn at will, as suggested by the Senator from Washington [Mr. Bone], or is the patent during its limited life a right of property entitled, like all other forms of property, to constitutional protection?

The answer has been given many times. It was summed up in 1918 by Chief Justice White for a unanimous Court in the famous case involving the interpretation of the act of 1910, authorizing the United States, but not its contracto, to engage in the unlicensed use of patents. The Chief Justice declared:

> At the time of the enactment of the Law of 1910 the following principles were so indisputably established as to need no review of the authorities sustaining them, although the leading cases as to all the propositions are referred to in the margin.
>
> (a) That rights secured under the grant of letters patent by the United States were property and protected by the guaranties of the Constitution, and not subject therefore to be appropriated even for public use without adequate compensation (Chief Justice White in Cramp & Sons S. & E. B. Co. v. Intnl. Curtis M. T. Co., 246 U. S. 39-40)

Years before, Mr. Justice Bradley, in a similar summing up of the status of the law, had declared:

> That the Government of the United States, when it grants letters patent for a new invention or discovery in the arts, confers upon the patentee an exclusive property in the patented invention which cannot be appropriated or used by the Government itself, without just compensation, any more than it can appropriate or use without compensation land which has been patented to a private purchaser, we have no doubt. The Constitution gives to Congress power "to promote the progress of science and useful arts by securing for limited times to authors and inventors, the exclusive right to their respective writings and discoveries," which could not be effected if the Government had a reserved right to publish such writings or to use such inventions without the consent of the owner (James v. Campbell, 104 U. S. 356).

With prophetic foresight, the Court met suggestions which have been made in the course of hearings on the pending bills, saying, in the same case:

> The Government of the United States, as well as the citizen, is subject to the Constitution; and when it grants a patent, the grantee is entitled to it as a matter of right, and does not receive it, as was originally supposed to be the case in England, as a matter of grace and favor.

In 1927 the Supreme Court was confronted with the question of whether a Federal statute was to be so construed as to deprive an assignee of a patent owner of a cause of action not only against the Government, but also against the infringing contractor. Mr. Justice Taft, speaking for the Court, declared that such a construction would raise a serious question of constitutionality under the fifth amendment. To avoid doubting the constitutionality of the act of Congress, the Court preferred to presume that Congress—

> intended to secure to the owner of the patent the exact equivalent of what it was taking away from him (Richard Screw Anchor Co. v. U. S., (275 U. S. 345)).

Nor to this day can any case be found in which any Federal court has done other than recognize that patents are on a parity with all other property.

Yet, Mr. President, a patent is unique property; for to acquire the property right to a patent for a limited time the owner agrees to give away that property right at the expiration of the fixed period.

There would doubtless be less confusion if critics had read the statement of Webster, made 90 years ago:

> The Constitution does not attempt to give an inventor a right to his invention, or an author a right to his literary productions. No such thing. But the constitution recognizes an original, preexisting, inherent right of property in the invention and authorizes Congress to secure to the inventors the enjoyment of that right. But the right existed before the Constitution and above the Constitution, and is a natural right, more clear than that a man can assert in almost any other kind of property (The Writings and Speeches of Daniel Webster, vol. 15, p. 438).

Furthermore—

said Webster—

> the right of an inventor to his invention is no monopoly. It is no monopoly in any other sense than a man's own house is a monopoly (id.).

This is apparent when we consider that one may exclude any one from the use of his house or his hat, or permit the use of either upon such terms as he may choose. One may sell, rent, or give away his house. He may occupy it or not occupy it. He may rent it for such period as he likes, and limit in any lawful way its use. But he may not use it to violate the law, any more than he may use a patent for such a purpose. But no one ever suggested the destruction of property rights in realty or personal property because it had been misused.

One of the great authorities on our patent system calls attention to the following fundamental facts:

> (1) Patents represent an addition to and not a subtraction from the public wealth; the giving of something to the public, not taking anything away from it.
>
> (2) A patent is the reward to the patentee for the creation of something new, the disclosure thereof and its entrance into the public domain upon the expiration of the patent. It is a stimulus to invention and disclosure thereof.
>
> (3) The patentee's control over his property is temporary.
>
> (4) A patent at best is a precarious and highly speculative kind of property.
>
> (5) A license does not create any new monopoly—the patent itself creates the monopoly—and a license is essentially a waiver, in favor of the licensee, of the monopoly held by the patent owner. (George E. Folk, Patents and Industrial Progress.)

Finally, the nature of the so-called patent law monopoly is stated with remarkable clarity in the recent words of the dean of the Northwestern Law School, the great law teacher, John H. Wigmore, in an introduction to a recent work, Patents and the Antitrust Law. He says:

> I take the opportunity to intrude my personal opinion, that neither courts nor treatise writers have been radical enough in defending the legitimacy of the "monopoly" in a patent, as distinguished from the ordinary trade monopoly. Is it not a fact that every property right that we have is a "monopoly"? The right to our house or our automobile is simply a right to keep anyone else from entering or using it without our consent, and is that not a monopoly? Take the case of the miner; he discovers a deposit of gold; he stakes it out and registers it, and he gets a monopoly—and not merely for 14 years, but forever! Yet no one ever publicly attacked his monopoly or proposed to cut down its duration, or to take it away from him unless he worked it; and so on. When Sir Isaac Newton, by thinking and thinking, discovered the law of gravity, and when Alexander Bell, by thinking and tinkering, discovered electric telephony and the California gold miner, by digging and sinking, discovered gold, they all three were doing an identical thing, i. e., discovering a condition of nature which had been existing all along but nobody else had ever found it out. Yet the third man gets a perpetual property right—monopoly; the first one gets no legal recognition at all; and the second one is awarded grudgingly a temporary right, and every once in awhile he is reproached for even that temporary "monopoly" (id., p. vii; January 31, 1942).

To date the Supreme Court of the United States has made plain the nature and limit of the patent as property. It has definitely set its boundaries and greatly fortified the Government in any attack upon the misuse of the patent, making it clear that beyond the limits of the patentee's definite rights, situations arising under the Antitrust Acts are dealt with as though the patent did not exist.

Mr. President, I believe there is also public misunderstanding of the present right of the Government to use patents in the war effort, with or without the patentee's consent. We should know our present law before we attempt the writing of new law.

## The Present State of the Law on Unlicensed Production by or for the United States

Is it true that the United States is presently hampered by the inability to use or authorize the use of patents necessary for war production? I deny the truth of any assertion to this effect. It is expressly provided by statute (act of June 25, 1910, as amended by act of July 1, 1918) that anyone in time of war or peace can manufacture anything for the Government as a contractor or subcontractor without liability for the use of applicable patents, the United States assuming responsibility for com-

pensating the patent owner; and neither itself nor its contractor can be stopped by injunction.

The act of 1910 was thought to accomplish this purpose, but was held to apply only to unlicensed production by the Government itself *(Cramp & Sons v. Intnl. Curtis M. T. Co.*, 246 U. S. 28, March 1918).

A month later Acting Secretary of the Navy Roosevelt communicated to the Chairman of the Committee on Naval Affairs of the Senate the situation resulting from this decision. It held, he said—

that a contractor for the manufacture of a patented article for the Government is not exempt, unless he is only a contributory infringer, from injunction and other interference through litigation by the patentee.

The substance of the amendment thereafter adopted was:

Whenever an invention described in and covered by a patent of the United States shall hereafter be used or manufactured by or for the United States without license of the owner thereof or lawful right to use or manufacture the same, such owner's remedy shall be by suit against the United States in the Court of Claims for the recovery of his reasonable and entire compensation for such use and manufacture (title 35, sec. 68, U. S. C. A.).

The statute in its original and in its amended form has received broad construction in many cases in the courts below and from the Supreme Court of the United States. In the first case in which it was construed, in the district court of New York *(Foundation Company* v. *Underpinning and Foundation Company*, 256 Fed. 374, Jan. 27, 1919), the plaintiff alleged a patent infringement by a subcontractor on the United States Assay Building, who was asserted to be using the plaintiff's patents in caissons for the foundation. An injunction was immediately sought. The injunction was denied, and the court pointed out that the act of July 1, 1918—

Was intended, in any event, to prevent the issuance of an injunction in a case such as that at bar.

The court said:

It may fairly be assumed that the amendatory act of July 1, 1918, was enacted to overcome the delays and difficulties which confronted the Government in the use of patented articles, and which was still possible under the act of 1910, as that act had been construed by the Supreme Court.

The case at bar was alluded to as "typical" of the condition to which a statute was addressed.

This case was never appealed, but has frequently been referred to and quoted with approval, notably in *Luellen* v. *Baldwin Locomotive Works* (C. C. A., 20 Fed. (2d) 449). It has been subsequently held that a manufacturer under a supply contract with the Government may not be enjoined, even though it be alleged that an accounting would show manufacture for individual private customers. It was held that Congress intended the Government to be free to contract with anyone for any article used by it. The only remedy by a patent owner against the use of a patented invention by or for the United States without license of the owner was in the Court of Claims, and not a United States district court *(Floyd Smith Aerial Equipment Co.* v. *Irving Airchute Co.*, C. C. N. Y., 276 Fed. 834, 1921).

The Court of Claims held that not even an infringing contractor manufacturing for the Government's account could voluntarily appear as a defendant. Only the United States could be such under the act of 1918 *(Waite* v. *U. S.* 57 Ct. Cls., 546, 1922).

The act of 1918 was qualified by holding that a contractor not required to infringe a patent by his contract could not claim the benefit of the act of 1918 for unnecessary infringement of his own free will *(Wood* v. *Atlantic, Gulf and Pacific Co.*, 296 Fed. 718, D. C. Ala., 1924).

In an action brought in the district court against a defendant constructing gun mounts for the United States, the court held that plaintiff's remedy for infringement was exclusively in the Court of Claims *(Luellen* v. *Baldwin Locomotive Works* (11 Fed. (2d) 390, D. C. Pa., 1926); affirmed C. C. A. 20 Fed. (2d) 449, 1927).

An employee of the United States being outside the benefit of the act of 1918 required a special act of Congress to enable him to sue under it *(Van Meter* v. *U. S.* (47 Fed. (2d) 192, C. C. A. 1931)).

Apparatus being manufactured and sold to the Coast Guard, and it being an agency of the United States, any infringement must be an action against the United States in the Court of Claims *(Hazeltine Corp.* v. *General Electric* (19 Fed. Supp. 898, 1937)).

The Federal Government did construction work for a municipality. The Government's contractor was alleged to have infringed patents in the making of sluice gates. The Federal court dismissed the bill against the contractor on the ground that the sole remedy was against the United States in the Court of Claims *(Browne* v. *Hardy-Tynes Manufacturing Co.* (92 Fed. (2d) 886, C. C. A., 1937)).

After the above followed the case of *Olsson* v. *U. S.* (25 Fed. Supp. 495, C. Cls. 1938). This was a suit against the United States to recover compensation for the infringement of a gun patent. The case was interesting in that it placed all patentees whose inventions were used by the Government on the same plane; that is, it obliterated the distinction between patents used by agreement and those infringed, each being entitled to just compensation.

The case which followed—*Pierce* v. *Submarine Signal Company* (25 Fed. Supp. 862, D. C. Mass., 1939)—was an action in the district court for the infringement of certain patents with interrogatories filed by the plaintiff. Objection was made by the defendant on the ground that the interrogatories related to apparatus sold to the United States. The district court held that it was without jurisdiction to entertain even interrogatories under these circumstances since exclusive jurisdiction was vested in the Court of Claims.

The last case of record *(Pollen* v. *Ford Instrument Co.*, 108 Fed. (2d) 62 C. C. A. 1940) follows the pattern of previous cases.

While the lower courts were interpreting the statute of 1918, the Supreme Court in 1928 also considered it *(Richmond Screw Anchor Co.* v. *U. S.*, 275 U. S. 331). This was an appeal from the Court of Claims by the assignee of a patent owner for infringement by the Government's contractor. The Government asserted that section 3477 of the Revised Statutes voided the assignment.

Mr. Justice Taft for a unanimous Court pointed out that if this were true it took away from the present owner—

not only the cause of action against the Government but also deprived it of the cause of action against the infringing contractor for injury by his infringement. The intention and purpose of Congress in the act of 1918 was to stimulate contractors to furnish what was needed for the war without fear of becoming liable themselves for infringement to inventors or the owners or assignees of patents.

The Court previously pointed out that the broad purpose of the amendment was—

to relieve the contractor entirely from liability of every kind for the infringement of patents in manufacturing any thing for the Government and to limit the owner of the patent and his assigns and all claiming through or under him to suit against the United States in the Court of Claims for the recovery of his reasonable and entire compensation for such use and manufacture (id. 343).

Following this broad statement the Court pointed out that if it were held that section 3477 of the Revised Statutes destroyed the right of an assignee, it would leave neither a remedy against the Government nor a private infringer and such a construction would raise a serious question of constitutionality under the fifth amendment. The Court, therefore, sustained the view that it was the intent of Congress "to secure to the owner of the patent the exact equivalent of what it was taking away from him." It was therefore held that the defense did not apply.

It is clear from the above cases that the act of July 1, 1918, removed all obstacles to anyone contracting with the Government as a primary or subcon-

tractor when manufacturing for its account and under its direction. The Government, furthermore, assumes all liability for just compensation. This it does not do under Senate bill 2303, as is plainly required under the fifth amendment.

The act of 1918 applies to all patents issued by the United States, whether owned by the citizens or others. In addition, the Trading With the Enemy Act of October 6, 1917, authorizes the Government to seize and administer all patents owned by enemy aliens, the Alien Property Custodian acting as the agent for the President.

It is furthermore to be noted that the act of 1918, like all other exercises of the power of eminent domain, authorizes the ultimate determination of just compensation by judicial proceeding. But above all, it cannot be overemphasized that by whatever form of action the United States takes or authorizes the taking or using of private property for a public purpose, it must assure just compensation.

In addition to its rights under this 1910 act, as amended, the Government now possesses the further authority under section 9 of the Selective Service Act to require any person or corporation to accept a contract from the Secretary of War or Navy for reasonable compensation to manufacture or to engage in other than its usual forms of production for our war needs if, in the opinion of such agencies of the Government, it is qualified to do so. The penalty for refusal is fine and imprisonment for the recalcitrant company, and seizure and operation of the plant by the Government.

Furthermore under the Requisitioning Act of October 16, 1941, the President is authorized on a finding of fact after reasonable efforts have failed to requisition military and naval supplies, material, and machinery. And, finally, under the Lend-Lease Act, these powers extend to the use of all this authority for production and transfer to our allies on such terms as may be fixed by the President.

If there be any gap in these tremendous powers, as is suggested by Mr. Shea, in production for civilian requirements, it may be met by a very simple amendment without either undertaking to deny that patents are property or to impair the integrity of the patent system.

There is a suggestion for the further amendment of the act of 1918, since its benefits do not apply to those "in the employ or the service of the United States," without special legislation. There may be many patent owners among those who enter the armed services or accept civil employment for the duration of the war. Surely these should not be penalized in their property for serving their Government. This may be an appropriate subject for amendment.

It is submitted that if legislation such as Senate bill 2491 is to be considered, involving as it does a variety of complex questions both of law and policy, it should await the investigation and report of the National Patent Planning Commission. The President appointed this Commission for the express purpose of extensively studying and making recommendations on every phase of the patent system so that this system should not be the subject of superficial study and hasty action. It should be accorded more patient consideration than has yet been given to the subject matter by the Patents Committee.

## Hearings on the Bills

The hearings of the Senate Committee on Patents began April 13 and recessed May 22. All appearing before the committee were sworn and submitted to cross-examination, in particular by the Senator for Washington [Mr. Bone] and special counsel to the committee, Mr. Creekmore Fath, an official for whom there is no authority in the resolution under which the committee has been acting.

Exclusive of Mr. Francis Shea, Assistant Attorney General, appearing April 14 to analyze Senate bill 2303, the various representatives of the Department of Justice appeared "in obedience to subpenas duces tecum" served by the committee on them or their superior and requiring them to produce hundreds of documents and exhibits, the character of which is suggested by the testimony of Mr. Allen Dobey, special assistant to the Attorney General attached to the Antitrust Division of the Department of Justice and engaged in prosecutions of the Sherman Act:

> * * * The documents I am producing and the facts they disclose were first revealed to the Government in 1940 when they were voluntarily submitted in obedience to a subpena duces tecum served in aid of a routine grand-jury investigation of possible violations of the Sherman Act. The subpena was issued June 19, 1941, and the documents which I am producing have been in the possession of the Department of Justice since some time last fall (p. 479).

The statements are varied by the declaration that others have been voluntarily submitted to the Department of Justice.

In specific instances, as on May 15, Mr. Charles D. Pack, special attorney, Antitrust Division, testified to a subpena served and declared:

> Yesterday a Federal grand jury, sitting in Trenton, N. J., returned an indictment charging 8 corporations and 20 of their officers and directors with a world-wide conspiracy to suppress competition in and to monopolize sales of dyestuffs in the United States and other countries in violation of the Sherman Antitrust Act. It is the story of the dyestuffs industry and of its organization that I propose to tell before this committee (p. 2193).

Mr. Arnold presented his familiar views within the whole patent field. Mr. Lewin presented the relations of the General Electric and its wholly owned subsidiary, the Carboloy Co., in the field of cemented tungsten carbide. Mr. Dobey testified in the field of tetracene, "the chemical compound used as a sensitizer or combustor initiator in the priming composition of firearm ammunition."

Mr. Hutchinson's presentation was devoted to the field of synthetic resins, and especially to acrylic plastics and the casting of methyl methacrylate which is shaped into sheets known as Lucite and Plexiglass, employed on military airplanes for cockpit enclosures, transparent bomber noses, gun turrets, landing light covers, and windshields.

Consent decrees and their uses were presented by Mr. Levi, an elaborate history of the German cartel system through Mr. Kronstein, while Mr. Pack gave an elaborate picture of the dyestuff industry, its condition before World War No. 1, the rights and development of the dyestuff and chemical industries during and after that, through the seizure and sale of the dominating German patents by the United States Alien Property Custodian, and the rights and development of the American industry, with the endeavor of the Germans and Swiss to reenter the American market.

The general character of these presentations involved the selection of correspondence, agreements, memoranda, or other documents from which selected parts were given to the committee with the interpretations and comments of the testifying officials. All such documents were subpenaed by the committee from the files of the Department to which they had come, either through the presentation by the companies involved, to grand juries, or investigators of the Department. The presentations, while therefore ex parte, were under oath.

Most of the records began about 1928 and a few were as late as 1941. They purported to show the business transactions of various American companies with owners of both foreign and American patents. In a number of instances either consent decrees had been obtained or practices complained of had been abandoned. In two or three instances, as in the case of the Carboloy Co., the General Electric lamp patents, and the dyestuff indictments, the cases were awaiting trial. How fair trials can be expected in view of these public assaults upon the defendants by officers

of the Government is difficult to see. It is difficult to resist the conclusion that the Antitrust Division prefers to try these indictments before a political committee rather than in a court of law.

Mr. Arnold, during his appearance on the 13th of May, presented a summary of two antitrust prosecutions awaiting trial and in doing so deprecated the partial presentation of correspondence or documents, which, however, was generally followed by all his predecessors and assistants. The committee session of May 13 was substantially given to examination of why pending prosecutions had been delayed at the request of the Army or Navy Departments because of their interference with war production.

In substantially over a month only three witnesses appeared on behalf of companies which were the subject of attack or severe criticism, and they received scant consideration. The Carboloy Co. appeared through its chairman, Mr. Jeffries, the Rohm-Haas Co., a Philadelphia corporation, through its secretary, S. C. Kelton and Messrs. Dzus, President of the Dzus Fastener Co. and his counsel, D. H. Kane. A public statement by the Carboloy Co. in response to criticism led to the recall of Mr. Lewin on May 7 for a sharp reply. Testimony of Mr. Kelton on behalf of the Rohm-Haas Co. (p. 869) is an excellent illustration of the dangers of ex parte testimony, since his evidence and that of Mr. Dzus (p. 1808) in my opinion completely disposed of the charges made.

The whole body of the Department of Justice testimony, occupying many days of delivery, so far as it tended to show alleged violations of the antitrust acts by the use of patents, in my judgment, is completely met by the continuing and most recent decisions of the courts, heretofore alluded to, which show how completely and broadly the Antitrust Act has been interpreted as a controlling remedy.

Even before the later decisions, Mr. Arnold in his own well-known publication, examining the use of patents to violate the antitrust law, declared:

> Such situations are easy to deal with if there is an organization in the Antitrust Division able to take care of complaints, and to watch the distribution of the principal necessities of living. If that organization is on the job ripples of one antitrust investigation will spread in all directions.

All Mr. Arnold has to do, as he has recognized, is to present in a judicial proceeding his particular facts, and the courts have never failed to sustain violations of the antitrust acts by their use.

The antitrust presentation before the Patents Committee has added nothing to the argument for Senate bill 2303, and has not reinforced the proposals for permanent legislation in that bill.

It is to be noted that Senate bill 2491 was at no time subjected to analysis such as Attorney General Shea gave to Senate bill 2303.

It is finally to be observed that so far the hearings have been not only ex parte, with the exception of three representatives of companies subjected to criticism, but numerous applications for hearings by businessmen, lawyers, persons of special patent experience, inventors, and scientists have not resulted in opportunities for hearings. Neither has the Secretary of Commerce nor the Commissioner of Patents, representing the department of the Government charged with the administration of the patent law, been invited to appear or to make any suggestions or recommendations.

While the pending bills attack the very essentials of the patent system, no one has paid the system more practical tribute than the distinguished chairman of the Temporary National Economic Committee, the Senator from Wyoming [Mr. O'Mahoney], one of the cosponsors of the pending bill. Immediately after the presentations on the subject of patents before the T. N. E. C. the Senator made the following statement:

> There seems to be a general agreement by these witnesses, as well as by those who previously testified at the Department of Justice hearings some weeks ago, that inventors and business still need the protection and stimulation of patents.
>
> The fact that patents are keystones in many industries has been brought home to us with great emphasis. I doubt whether I had realized their significance as a primary force in the operations of the economic system. These hearings may lead more of us to give to patents the attention they so certainly deserve.
>
> There was practically unanimous agreement among the witnesses that Congress, by the enactment of the patent law, has given this country a system far superior to that which exists in any other country (January 24, 1939).

In a letter to the Senator from Washington [Mr. Bone], chairman of the Patents Committee, the President said:

> It is fitting that you should open these hearings on April 13, the birthday of Thomas Jefferson, who was our first superintendent of patents. No surer guidance for your action could be found than a constant consciousness of the spirit and intent of that great designer of American democracy.

I join in this admonition that the spirit and intent of Jefferson should guide the lawmakers of today in this field of enterprise and law. Jefferson drew a sharp distinction between trade monopolies, which he detested, and the limited patent monopoly to which he gave approval. I urge his views and his intent upon the membership of the Senate and the committee. Jefferson said:

> An act of Congress authorizing the issue of patents for new discoveries has given a spring to invention beyond my conception. * * * In the arts, and especially in the mechanical arts, many ingenious improvements are made in consequence of the patent right giving exclusive use of them for 14 years. Certainly an inventor ought to be allowed a right to the benefit of his invention for some certain time. Nobody wishes more than I do that ingenuity should receive liberal encouragement (Patents and Antitrust Law, Laurence L. Wood, p. 17, exhibit B).

Mr. President, I have made this long talk because of my belief that there exists in the public mind a misconception as to what a patent is, and as to both private and public rights affected by the issuance of a patent as such rights have been defined by our courts; because I am persuaded that in these hearings the law has been stated to be what it never has been, what it is not now, and what it should not be; and finally, because of my feeling—and I say this with regret—that the Patents Committee of the Senate is not studying the problems presented in the spirit and purpose which the questions and the public interest involved demand. I have given much study to the record thus far made in the committee hearings. I feel constrained to express the hope that the Senate will view with critical eye recommendations based upon that record as it now stands.

Mr. President, I believe, as did Jefferson, that the granting of patents has given a spring to invention beyond conception. I believe our patent system has made an amazing contribution to the industrial life of our country and to the comfort and betterment of all our people. I hope it is not to be thoughtlessly and recklessly dealt with by the administrative agencies of our Government or by the Congress.

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PETROLEUM ENGINEER Exclusive Feature

# Patent Rights and the Patent System

*by Frederic Penn*[1]

THE ATTACK on patents and the patent system by the Anti-trust Division of the U. S. Department of Justice, has created a false impression about patents in general.

The attack is directed at patent pools for alleged "abuse" of patent rights, particularly by big business. The principal "abuse" is that the patent privilege has been one of the means whereby domestic and international cartels or patent pools maintain their monopolistic control over our markets at home and abroad.

One of the causes for this "abuse" of the patent privilege is that American concerns, by exchange of patent rights, were able to obtain from German industrialists their American patent rights for:

Tetracene, a percussion explosive. Information obtained from Germany by the Remington Arms Company.

Optical glass and instruments. Information obtained from Germany by the Bausch and Lomb Company.

Plexiglass, a plastic glass used for airplanes. Information obtained from Germany by Rohm and Haas.

Carboloy, a tungsten steel alloy used for hardening steel. Information obtained from Germany by the General Electric Company.

Buna rubber, a synthetic rubber substitute. Information obtained from Germany by the Standard Oil Company of New Jersey.

Magnesium, a substitute for aluminum. Information about new processes obtained from Germany by the Aluminum Company of America.

Atabrine, a substitute for quinine. Information obtained from Germany by the Winthrop Chemical Company.

Synthetic toluol for TNT. Information on which American process is based obtained from Germany by the Standard Oil Company of New Jersey.

Were it not for the beneficial operation of the American patent system, these strategic materials would not now be available to American industry.

Some of the so-called "abuses" are retarding industrial progress and restricting production, because an inventor who has invented something new and useful to advance the art in an industry is not compelled to make available his invention to all others. For this reason, it is alleged that industrial progress is retarded and production is restricted.

To remedy these "abuses" it has been proposed that invention and research should be taken away from private industry and turned over to government departments. Other remedies proposed in Senate Bill S2730 provide for imprisonment or fine if the owner refuses to grant patent licenses to others, and that a copy of any assignment of patent rights must be filed with the attorney general.

In order to determine whether there is any "abuse" of the patent privilege, whereby monopolies are created and trade restrained, it is necessary to know what a patent is and what are the rights granted, and what is a monopoly.

A patent is a grant for a limited time for an exclusive privilege to an inventor by the government to exclude anyone from making, using, or vending the thing patented without permission of the patentee. Patents are granted to an inventor only for things that are new and useful and not known or used by others before his invention.

## What Is a Monopoly?

A monopoly may be a grant, franchise, or commission to any person, persons, or corporation for the sole buying, selling, making, working, or using of anything whereby any person, persons, or corporation is restrained from any freedom or liberty that he enjoyed before, or is hindered in his lawful trade.

A monopoly may be a regulated public utility that has an exclusive grant or franchise to supply water, gas, electricity, or telephone service in a given area.

A monopoly may be a combination of competing companies to control trade, or a monopoly in trade may be brought about by means of contracts to control prices and thereby concentrate the control of business under a few individuals. This kind of monopoly is not created by legislation, grant or franchise, and is illegal when its operations tend to restrain interstate commerce.

A monopoly connotes an exclusive privilege to sell or use a thing that the public freely enjoyed prior to the grant. Thus, a monopoly of this kind takes something from the public that it previously had.

The exclusive privilege conferred upon an inventor by grant of a patent for a new and useful invention is not a monopoly of the type commonly conceived, as the exclusive privilege of a patent grant does not take anything from the public, because the new and useful invention did not exist prior to the invention. An inventor has a natural or common-law right separate from, and independent of, any patent grant to make, use, and vend his invention by keeping it a secret.

A patent grant, with the exclusive privilege, is not a reward for invention, but a reward for the full and complete disclosure of the invention, so as to enable the utilization of the invention by the public upon the expiration of the patent.

Under the patent laws, the patentee may manufacture, use, or sell the thing patented, or license others to do likewise. The patentee may license others either to manufacture, use, or sell the thing patented, in restricted territories, and prohibit the licensee from competing with the patentee of the thing patented. These rights are sanctioned by the federal constitution and defined by the federal statutes.

No exclusive right may be granted for anything that the patentee has not invented or discovered. If he claims anything that was known before, his patent is void. The right of the patentee rests entirely upon his invention or discovery of that which was not known before. This does not partake of the character of monopoly.

The patent laws do not permit the owner of a patent to violate the anti-trust laws by reason of his patent grant.

## Section III, Clayton Act

It shall be unlawful for any person engaged in commerce in the course of such commerce to lease, make or sell or contract for the sale of goods, wares, merchandise, machinery, supplies or other commodities, whether patented or unpatented, for use, consumption or resale in the United States or any territory thereof, or the District of Columbia, or any insular possession or other place under the jurisdiction of the United States, or fix a price charged therefor or discount or rebate upon such price, on the condition, agreement or understanding that the lessee or purchaser thereof shall not use or deal in the goods, wares, merchandise, machinery, supplies or other commodities of a competitor or competitors of lessor or seller, when the effect of such lease, sale or contract for the sale on such condition, agreement or understanding substantially lessens competition and intends to create a monopoly in any line of commerce.

## Improper Use of Patents

An owner of a patent may not control the sale of unpatented materials used in a combination or process. The American Patents Development Company, owner of a patent for a refrigerated transportation container for shipping food products refrigerated with solid carbon dioxide, and the Dry Ice Corpo-

[1]The author, an executive of the Tretolite Company, has an intimate knowledge of the patent system as it applies to the chemical industry and chemical processes.

ration, an exclusive licensee, brought suit against the Carbice Corporation, a manufacturer of solid carbon dioxide, as a contributing infringer, for supplying solid carbon dioxide, an unpatented product, to customers of the Dry Ice Company, knowing that the carbon dioxide was to be used by the purchaser in transportation containers like those disclosed in the patent of the American Patents Development Corporation. The patent owned by the American Patents Development Corporation was not for solid carbon dioxide, but for a transportation container wherein solid carbon dioxide was used as a refrigerant. The Supreme Court stated, "The invention claimed is for a particular kind of container, employing solid carbon dioxide in a new combination. The owner of the patent can prohibit the manufacture, sale or use of such container, or he can grant licenses on terms consistent with the scope of the patent. He may charge a royalty fee, but he may not exact as a condition of a license that the unpatented solid carbon dioxide used in combination with the patented container shall be purchased only from the licensor."

This doctrine of the Carbice case was applied in International Business Machines Corporation versus United States. This case involved an appeal from a decree enjoining the International Business Machines Corporation from leasing its patented tabulator machines on condition that the lessees shall use such machines only on unpatented tabulating cards manufactured by the International Business Machines Corporation. The U. S. Supreme Court stated, "The Clayton Act denies the lessor of patented as well as unpatented machines the benefit of any condition or agreement that lessee shall not use supplies of competitors."

The Carbice doctrine was carried still further in Leith Manufacturing Company versus Barber Company. The Barber Company owned a process patent for a method of retarding evaporation from concrete roads during curing. The material used in practicing the process was emulsified asphalt, an unpatented product manufactured by both Leith and Barber. The Barber Company granted no license to anyone to practice the process, yet anyone buying asphalt from the Barber Company for the purpose of practicing the process received an implied license. In this manner the Barber Company sought to use the process patent for the purpose of obtaining a limited monopoly on emulsified asphalt. The Barber Company sued the Leith Manufacturing Company for contributory infringement of its own process patent for making sales of emulsified asphalt to road builders, with the knowledge the asphalt was to be used for practicing the Barber Company process.

The Supreme Court held that the Barber Company patent did not cover a right to be free from competition in supplying unpatented material to be used in practicing the invention, and any use of the patent as a means for obtaining a limited monopoly on unpatented materials was prohibited.

The courts have re-affirmed the doctrine of the Carbice case whenever an owner of a patent has attempted to control the sale of unpatented materials by means of patents.

### Unlawful Patent Pools and Cross Licensing

Under the anti-trust laws, an owner of a patent may not enter into agreements with manufacturers or dealers by means of patent interchange, when used to effect a monopoly, fix prices, and unreasonably restrain trade in interstate commerce. These agreements are not only beyond the scope of the patent grant, but also violate the anti-trust laws. The Supreme Court has held that attempts to regulate future prices or future marketing of patented articles after a complete sale by the patent owner, are not valid exercise of the patent grant, and are unlawful restraints of trade in interstate commerce.

Where domination exists, the pooling of competing patents or exchange of licenses for the purpose of controlling the manufacture and supply of a product, is beyond the privileges granted by the patents and constitutes violation of the anti-trust laws. In United States versus Masonite Corporation, Celotex Corporation, Certainteed Products Company, et al., the Masonite Corporation, manufacturer of a patented wall board, entered into license agreements with Celotex Corporation, Certainteed Products Company, and other manufacturers and sellers of wall board competing in the same market. The license agreements were to maintain prices on all wall board as prescribed by the Masonite Company. The Supreme Court held that the prices of wall board were based on mutual agreement and therefore violative of the anti-trust laws.

### Lawful Patent Pool, Cross Licensing

Cross licensing agreements between owners of patents are not in violation of the anti-trust laws when no selling price fixing is involved, or restraint of competition among the owners of the patents. Accessibility by the parties to their respective patent claims is frequently necessary if technical advance is not to be blocked by threatened litigation, and, as cross licensing may promote rather than restrain competition if the valuable advantages are available upon reasonable terms to all manufacturers assigned to participate. In Standard Oil Company of Indiana versus United States, the Court stated, "Cross licensing agreements between few owners of oil cracking patents held not in violation of Sherman Act on ground that provision was for division of royalties, as the agreements did not restrain competition among the licensees."

### Lawful Price Fixing

The owner of a patent does not violate the anti-trust laws by disposing of his articles made under his patents, directly to the consumer, and fixing the price at which his agents transfer title directly from him to the consumer.

Through a system of contracts between the General Electric Company, which owned patents for electric lamp with tungsten filaments, and manufactured most of those sold, and a large number of wholesale and retail dealers in electrical supplies, the dealers were appointed agents of the company to sell the lamps at a fixed price. In United States versus General Electric Company, the Supreme Court held the dealers were genuine agents and the plan was not a device to fix prices after sale and to retard trade and exercise a monopoly in lamps in violation of the anti-trust laws.

The courts have consistently held that the owners of patents may license or refuse to license, as they choose, and whether the refusal to license is based on a commendable or odious reason is immaterial. The patent owner may fix the price of the patented article and restrict its use. It is only when he adopts a combination with others and steps out of the scope of his patent rights and seeks to control and restrain those to whom he has sold his patented article in their subsequent disposition, that he comes within the anti-trust laws.

Combinations, conspiracies, contracts between competing companies to fix prices, when used to effect a monopoly or to interpose an unreasonable restraint upon interstate commerce by means of patents, is not within the scope of the patent laws. These illegal combinations, conspiracies, and business practices are violations of the anti-trust laws.

The alleged "abuses" of the patent system are without sanction of the patent laws. The enforcement of the anti-trust laws will stop any abuse involving the use of patents. There is nothing wrong with the fundamental principles of the patent laws. Our present leading technological and industrial position is due to our patent system.

The present patent statutes have withstood the test of time and should be protected against unwarranted so-called reforms.

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# Inventions in the Oil Industry

PETROLEUM ENGINEER Exclusive Feature

☆ **A discussion of patented inventions in the oil industry and how they have contributed to progress—What of proposed patent legislation?**

*by Jack A. Schley*

CAN the oil industry maintain its rate of progress without inventions? If proposed patent legislation is enacted, what effect will it have on future oil-field production and oil and gas processing inventions? Will such legislation benefit the industry or will it react unfavorably?

This article is an endeavor to present both sides of the problem and to offer sufficient facts and commentary upon which the reader may draw his own conclusions.

## Oil Industry Progressive

An examination of the Patent Office Gazette, published weekly, reveals that a proportionately large number of patents are issued on oil and gas inventions. Many of these inventions have been born of a crying need and not infrequently the cry for them has come from the operators, drillers, and refiners. Patented devices are specialties and are made by specialty manufacturers, most of whom are classified as small companies and individuals.

Regarding instances of inventions that have played a considerable part in the development of the production of oil and gas, there are too many to enumerate. Among the outstanding inventions are: an emulsion treater that practically revolutionized the treatment of crude oil emulsions at a reduced cost per bbl. and a saving in gravity; a time-controlled oil flowing device that conserves gas and operates at low cost; bottom-hole chokes and regulators recognized as great improvements; oil-well surveying and orienting devices of superior merit; well swabs, thousands of which have been used; casingheads and tubingheads, products on which several successful companies have been built; successful distillate gas processes; a widely used gate valve; several drilling bits; gun perforators; cementing devices; bubble trays, etc. The institutions built on these inventions have given employment to thousands of men and have involved in excess of $25,000,000. It is conservative to say that none of these inventions would have been born and developed to the benefit of the industry, had it not been for patents.

**JACK A. SCHLEY**

Patent Lawyer, was born in Baltimore, Maryland—Entered patent practice at Washington, D. C., in 1898—Went to Texas in 1907—Has acted as attorney in the issue of more than 5000 patents, at least 1000 of which related to the oil and gas industry—Has represented patentees in infringement suits throughout the United States—Admitted to practice in Texas Courts, U. S. District Courts, North and South Texas Districts, Patent Office, Fifth and Tenth U. S. Circuit Courts of Appeal, Court of Customs and Patent Appeals, and U. S. Supreme Court—Is a member of American, Texas, and Dallas bar associations—Member of Patent Law Revision Committee of American Bar Association, representing the Southwest.

Examine an oil or gas well from the top of the derrick down to the producing formation and you will find nearly every piece of present-day equipment to be the result of the hard-earned efforts of that group of optimistic and courageous thinkers, the inventors. Most difficulties appear simple when once overcome. The contrast is spectacular when one looks back upon the equipment used on the Drake well and in the oil fields of the early years. Refining methods and equipment have also been revolutionized by inventions.

Because of patent protection the operators and manufactureres have felt free to permit their technical men to prepare articles for publication and to address meetings of technical groups and associations and discuss equipment and operating methods. As a result, there has grown up a group of specialists who have the urge and the time to invent. If the patent system is so modified by restrictive legislation that it is not worthwhile to obtain patents, it is logical to conclude that the incentive to invent and patent will be seriously impaired, if not lost. The oil industry will be the loser.

The oil industry is comparatively young. There are those old timers whose calloused hands betoken the days when main strength and crude devices were the best to be had—when hours were necessary to perform ordinary operations. In the last 20 years there has been a marvelous mechanical advancement. Many know the Jones, Smiths, and Browns who have contributed their ingenuity in this era of marked achievement. The cadence of operations has been stepped high. Can we say that engineering and natural development would produce present-day de-

vices and equipment? Perhaps there are some who say "yes," but the writer from actual experience cannot subscribe to this conclusion. One supporting fact is the quickness and readiness with which new devices and equipment have been adopted.

We have two schools of thought, one that engineering and research would be sufficient, the other that invention, motivated by the inspiration to see original ideas successfully carried out and the expectancy of financial reward, would be necessary. The reader can take his choice. But as food for thought, it is generally recognized that that ability to invent is a talent, a gift, if you please, a creative mind full of optimism and not easily discouraged. A successful inventor is usually one who disdains to follow precedents and who doesn't believe anyone. He is usually a reticent fellow that prefers to keep his ideas secret rather than to give them away.

Engineering and research might maintain progress, but unquestionably the tendency to follow precedents and the exactness instilled by education and training, would at least slow down progress, and likely discourage attempting the impossible, which is often the inventor's greatest asset. Further, only the financially able can maintain engineering and research. Many of the most valuable oil and gas inventions have come from mechanics and oilfield workers that got tired of breaking their backs or had the natural ability and the ambition to get ahead. After the experts had failed I have seen an ex-roughneck invent a solution; however, it must not be inferred that all inventors come from the workmen ranks. Quite the contrary, a sizeable group includes executives, technicians, professors, and salesmen. Inventors are born—not made.

One visiting recent oil shows or expositions is impressed with the display of improved equipment and processes. The forewords have been safety, speed, efficiency, and economy, for the day of the inefficient and the spendthrift is rapidly fading. But don't let us become complacent—there is yet vast room for further improvement, which, if and when made, will cause present equipment to appear cumbersome and even crude. To accomplish this advancement, invention must be given a high place, but men will not disclose their inventions without worthwhile reward.

## Distribution of Patents

It is common opinion among the general public and possibly in the oil industry, that the large companies own or control the majority of patents. The Commissioner of Patents, Conway P. Coe, in making his report to the Temporary National Economic Committee, gave the following tabulation:

**Patents issued 1921-1938**

| | |
|---|---|
| Large corporations | 17.2 percent |
| Small companies and others | 82.8 percent |

**Distribution of patents**

| | |
|---|---|
| Individuals | 42.9 percent |
| Small corporations | 34.5 percent |
| Large corporations and subsidiaries (Assets over $500,000) | 17.2 percent |

**Patents acquired January 1, 1931 to July 30, 1938**

| | |
|---|---|
| Individuals bought | 976 |
| Small corporations bought | 7448 |
| Large corporations bought | 1124 |

This clearly shows that the so-called small companies and individuals are the majority holders in our patent system and any changes will affect them and their business to a greater degree than such changes would hamper the larger companies.

Nearly all complaints of abuses of patents have been charged to the larger companies, but facts show that even among these larger organizations, the offenses are confined to the minority insofar as patents are concerned. It is not the theme herein to array the small against the large, but to present facts. Dealing with inventions and patents as an entirety, it is obvious that no fair-minded person would prefer patent laws that unjustly hampered or injured the 82 percent to cure abuses occurring among a minority of the 17 percent of the patent owners.

Unfortunately the pendulum of reform usually swings too far and thus the force of balanced thinking is called upon to save the day. Too often, even well-meaning persons propose legislation without full investigation or from a prejudiced viewpoint. Inventions are a necessary adjunct to the oil industry, and the industry owes much of its progress to inventors. Proposed reform can change all this and place barriers in the path of future progress.

## Proposed Patent Legislation

Numerous bills, ranging from the sublime to the ridiculous, have been introduced in Congress proposing to reform our present patent laws. The most prominent subjects are: Compulsory licensing; declaring a patent a privilege, thus depriving the inventor of his constitutional rights; enabling the President of the United States to seize a patent for war purposes and to grant licenses thereunder not only for the duration, but for the remainder of the life of the patent; making a patent void if used to restrain trade; limiting a patent to a term of not more than 20 years from the date of filing the application; modifying the present interference practice, and some bills creating "gravy-train" governmental agencies. It is doubtful whether it would be profitable to discuss or read the mechanics of all these bills, but some are worthy of comment.

## Compulsory Licensing

Bills relating to compulsory licensing propose that within a term, usually three years, after the issue of the patent, any manufacturer may apply for and be granted a license under the patent. This bill is designed to prevent suppression of improvement patents. A survey shows that compared with the large number of patents issued each week, the cases of suppression or shelving are definitely minor. It is doubtful whether they would reach 2 percent of the total issued.

Such a law prevails in a number of foreign countries and it has not produced an overall benefit. There are substantially as many improvement patents issued in the United States as in all these countries combined. Compulsory licensing of patents in the United States would obviously greatly impair improvement inventing.

The writer knows of at least 100 specialty manufacturers in the oil industry who would be forced out of business should compulsory licensing become a law; further, many methods and processes would be held as secrets and would not be patented.

There is an illusion that if a man invents a better mouse trap the whole world will beat a path to his door. This is the rankest kind of "bunk." In some 40 years' experience I have seen the weeds grow up in front of many better mouse traps.

There are two very serious objections to compulsory licensing. One has to do with pre-development of the invention and the other has to do with the return of money invested.

Most inventors, even in the oil and gas industry, are unable to finance their inventions through the experimental, developing, and testing stages necessary before a commercial device is produced. I can recall hundreds of inventions not one of which went into production in its original form. It would surprise many how rapidly the necessary experimenting, developing, and testing of an oil or gas invention will consume $10,000. There are numerous instances of expenditures of $100,000 and up, before a promising invention reached the market—or failed to make the grade. A financial investment in an invention is highly speculative.

One occurrence of interest that came under the writer's observation had to do with developing a well device invention. The inventor brought the device to a certain specialty manufacturer who was sufficiently impressed to agree to spend several thousand dollars on it. Castings were made and machine work was done, but many devices were discarded before completion because the design was faulty—although no one lost faith in the device. After spending several thousand dollars, an acceptable device was completed.

The trouble had just begun, however, for on the first trial in a well it choked up, on the next trial sand cut out passages, on the next trial certain parts spread, on the next trial some parts wore out too soon—but optimism still prevailed. By this time the manufacturer was out more than $25,000, but the device finally went into production and after two or three years, was widely and successfully adopted by the industry.

What sustained the inventor? His enthusiasm to see his brain child grow up. What was the manufacturer's protection on his investment? A patent.

It usually requires from two to five years to obtain a profitable return upon money invested in an invention. Where is that credulous individual who will invest his cash, if any competing manufacturer can obtain a license to make and sell the patented device on the payment of a small royalty and without the expenditure of development and over which license the patent investor has no control?

A specialty manufacturer operating under a patent must obtain a substantial profit on the sale of his device, because of a more or less limited demand. A larger company selling a general line of equipment could obtain a compulsory license, put the device in its line, and so cut the price that it would spell ruin for the specialty manufacturer.

The proponents of compulsory licensing and mitigation of patent rights hold that competition would be accelerated and the public would be benefited by reduced prices—that the spice of rivalry among manufacturers would take the place of invention. It would seem that they have narrowed their vision. Without patent protection smaller companies would gradually be frozen out and thus the number of competitors would be greatly reduced.

History reveals that when competition is reduced to a relatively small group, particularly in a specialized field, control sets in that is not to the public interest. But, say the proponents of restrictive legislation, "the anti-trust laws will stop that." If this is true, why wait until the evil day? Why not invoke the anti-trust laws now.

## Other Legislation

If a man carves a horse from a wooden block, it is his physical expression of his own idea—the carved horse is his personal property and he may do with it as he pleases. An invention falls into the same classification—it is property. Will the inventor trade his property (his invention) for a patent that is a mere privilege, subject to the whims and fancies of some government agency? Would you relinquish the title to a producing oil well for such a privilege? The bill declaring a patent a privilege is unconstitutional, if that means anything, and would destroy the patent system.

The President of the United States already has full authority to seize a patent for war purposes. Why should the government need to keep the patent after the war is over? There may be a few patentees who are not fully cooperating with the government, but it is a reflection on American patriotism to accuse the vast majority of patent owners of impeding war production. Such an accusation cannot be believed.

## The Cure of Abuses

After mature consideration, the majority who have studied the subject believe the greatest evils charged to patents can be eliminated by proper anti-trust prosecution and perhaps some changes in the anti-trust and unfair competition laws. Why treat the water to stop the leak at the faucet?

## National Patent Planning Commission

The President evidently realizing that the reformers were running wild, appointed the National Patent Planning Commission to make a full investigation of our present patent system and report to him. His instructions regarding the duties of this commission are full and comprehensive. The commission is headed by Dr. Chas. F. Kettering and includes as members other capable business and professional men, as well as the Commissioner of Patents. The indications are that this commission will not report until after the war. Unquestionably, Dr. Kettering and his associates will fully investigate the effects of patents in the oil and gas business. It would seem only sensible to wait until this commission makes its report before attempting the enactment of further patent laws.

It is believed everyone will agree that the oil and gas industry as a whole has not suffered from patents; also that the incentive to solve some problem and invent an improved device has led to the creation of many original and efficient devices and methods that otherwise never would have been conceived. If this incentive is mitigated, if the expectancy of financial reward is taken away, and if progress in the oil fields is left to departmental research, the industry as a whole will experience a serious slowing down of its mechanical development. Anybody's business is nobody's business. Whenever initiative is obliterated, look for decadence.

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# Proposed Patent Changes and the Small Manufacturer

☆ Purpose of legislation would be defeated, as it would force small specialty manufacturer into direct competition with "big business"

PETROLEUM ENGINEER Exclusive Feature

*by E. H. Ackley*

EVERYONE is familiar with at least one small manufacturing concern whose very existence is dependent upon the exclusive rights granted to inventors under the United States Constitution and our patent laws.

The Federal Constitution provides that Congress shall have the power to promote the progress of science and useful arts by securing to inventors the exclusive rights to their discoveries for a limited time. Pursuant to this grant of power by the Constitution, Congress has enacted a patent statute that states, in general terms, that every patent shall contain a grant to the patentee of the exclusive right to make, use, and vend his invention or discovery for a period of 17 years.

Exigencies arising out of the global war in which we now find ourselves engaged have been made the basis for a renewed demand from some sources for sweeping reform of the present patent system.

## Changes Now Opposed

No serious change in such laws should be undertaken during a period of national stress. Instead, more normal conditions should be awaited when careful deliberation of the full effects of the revision may be undertaken, and the needs and opinions of all affected groups given due consideration.

Certain of the bills now before Congress would, if enacted, produce far-reaching changes in the American patent system. Hearings on these bills have emphasized the alleged improper use of patents as a medium for establishing monopolistic pools and cartels, and for the purpose of restraining trade and fixing prices.

**E. H. ACKLEY**

was born at Canyon, Texas, July 18, 1908—Attended the University of Pennsylvania, University of Texas, Trinity University, and the Dallas School of Law, the latter later being absorbed by the Southern Methodist University Law School, Evening Division—Received bachelor of science in physics and mathematics from Trinity University—Received bachelor of laws from Dallas School of Law with certificate from Southern Methodist University—Entered employ of Otis Pressure Control, Inc., in February, 1937, handling patent work—Also served as an engineer and draftsman—Is now attorney for Otis Pressure Control, Inc., and Otis Engineering Company—Member Dallas Bar Association, Texas State Bar, and American Bar Association.

It must be recognized that, by their nature, patents are actually grants of benificent limited monopolies to the inventors, but that the grant is grounded upon the premise that our patent system provides incentive to invention and for the investment of capital in new enterprises for the dominant purpose of promoting the progress of science and useful arts to the betterment of our national welfare.

## Senate Bill 2303

Probably the most widely publicized patent measure before Congress is Senate Bill 2303, which states in its title that it is a bill "to provide for the use of patents in the interest of national defense or the prosecution of war, and for other purposes." Senator O'Mahoney, before the Senate Committee on Patents, declared that "this is not a patent reform bill; this is really a war bill." It has further been stated that "its operation is limited to the time of war." The second section of the bill, however, contains provisions authorizing the President, "in the interest of national defense" not only during war time but also during "any period of national emergency" that he may declare to exist, to acquire inventions, patents, or patent applications, or licenses by gift, purchase, or taking; and, in turn to grant licenses thereunder.

The Act of June 25, 1910, as amended by the Act of July 1, 1918, has removed all obstacles to anyone manufacturing for the government or under its direction. As stated by the Boston Patent Law Association, "No legislation is necessary because the Government is already in a position to

proceed with the war effort without regard to patents. While it cannot seize the patent itself, it and its contractors, or anyone producing goods for the Government, can make the goods and leave the patentee to recoup himself by suit in the Court of Claims."

The provision of S. 2303 is not likely to affect materially the patents of most oil-field specialty manufacturers, as adequate quantities of such specialties can ordinarily be supplied to meet any demand, subject of course to the limitations imposed under the various priority regulations.

The enactment of measures such as proposed would violate the rights of due process, just compensation, and the freedom from discrimination guaranteed under the Constitution.

### Real Basis for Complaint

From the record it appears that the acts complained of at the hearings arose, in most instances, from agreements and combinations contrary to the public interest, not because of the exercise of the exclusive rights granted under patents, but because the acts and agreements violate anti-trust laws. Such conditions call for the enforcement and, if necessary, the revision of the anti-trust laws, rather than a material change in the patent laws.

Discussions of this aspect of the proposed patent law reforms are to be found in the writings of the Hon. Thurman W. Arnold, Assistant Attorney General of the United States; the Hon. Lawrence Langer, of the New York Bar; the Hon. Roy C. Hackley, of San Francisco, chairman of the Patents Section of the American Bar Association; in an address by the Hon. Wallace H. White, Jr., of Maine, in the United States Senate on June 29, 1942, and in the records of the hearings before the Committee on Patents of the United States Senate.

### Compulsory Licensing Plans

From the standpoint of the small manufacturer, the most serious effects of the proposed revisions to the patent laws are from those relating to the so-called "compulsory licensing plans," such as have been frequently advanced in the past and recently have again been proposed by the Temporary National Economic Committee.

Senate Bill 2491 follows closely the recommendations of the Temporary National Economic Committee in 1941. The bill provides for the following restrictions upon patents:

(1) The Commissioner of Patents may upon his own initiative, or upon complaint, investigate and determine whether a patent owner has failed for three or more years to make, use, or sell a patented invention, or to grant licenses thereunder for reasonable compensation, whether such action violates the anti-trust laws or is without reasonable justification. Upon a finding adverse to the patent owner, the Commissioner may issue licenses under the patent subject to review.

(2) No patent granted after enactment of the bill shall authorize selling, assigning, or licensing that imposes a restriction on the quantity or value of machines produced, the purpose for which or the manner in which the patent or any article produced thereunder may be used, or any limitation of the geographical area within which the patented article may be produced, sold, or used.

(3) Ninety days after the enactment of the proposed bill its terms shall apply retroactively to all agreements, understandings, or restrictions in effect with regard to patents granted prior to its enactment.

(4) Action for violation of (2) and (3) may be brought by the United States in any district court before a judge without a jury. If the decision is adverse to the patent owner or other defendant, a decree may be issued canceling the patent or extinguishing the limited rights, if any, of the defendant, subject to reversal upon appeal.

(5) Sales, assignments, or other conveyances of pre-existing or new patents, and all licenses or other agreements thereunder, must be in writing and filed with the Federal Trade Commission within 30 days after execution by the seller, assignor, or grantor. A penalty of $1,000 and $10 for each additional day for failure to comply is provided. The record is public and copies may be had upon payment of a reasonable fee.

(6) Suits for infringement against sellers or users of patented articles are prohibited unless the complainant first obtains a decree sustaining the patent and infringement against the manufacturer or supplier; and, contributory infringement suits are also prohibited unless the complainant is an assignor or vendor and has previously obtained a decree of infringement against the primary infringer.

(7) Conveying any patent or interest therein or granting any license that, through any condition, agreement, or understanding, tends substantially to lessen competition or grant a monopoly, would be unlawful unless the restriction was necessary to promote science or the useful arts.

(8) The Commissioner of Patents and the Federal Trade Commission are given power to conduct investigations, compel the attendance of witnesses and the production of books, records, and documents through aid of the federal district courts.

### Not a War Emergency Bill

This bill is not predicated upon the war emergency nor is the applicability of its restrictions limited to the duration of hostilities.

Under the provisions of this bill, as well as other bills now pending, every inventor or owner of a patent could be compelled to share his invention or patent with anyone who might desire to use it, by complaint to the Commissioner of Patents and a showing of nonuse or suppression as mentioned in (1) above. If the finding of the Commissioner is adverse to the patent owner then the commissioner may grant a license under the patent to the complainant.

There are no restrictions imposed upon the commissioner's power to grant licenses; they may be permanent unrestricted compulsory grants.

It is to be emphasized that, under the terms of the bill, no restrictions may be included in the licenses granted under the patents issued after enactment of the bill, which would limit quantities, affect prices, or fix limitations on the areas within which the rights licensed under the patent may be exercised. This provision is also made retroactive 90 days after passage of the bill and would apply to all pre-existing patents and the agreements existing under them. For violation of this provision, suits may be brought by the United States for cancellation of the patent or the rights granted thereunder.

The requirement that all conveyances, assignments, or transfers of patents, and all licenses or other agreements affecting patents, must be filed with the Federal Trade Commission would make such agreements open to the public. Also, these instruments would be subject to inspection by the office of the attorney general, and any such instrument tending to impose a restraint upon trade or other restriction repugnant to the anti-trust statutes would certainly require revision. This section of the bill has been generally approved in principle.

The terms of paragraph (7) are tantamount to an ambiguous amendment to the anti-trust statutes.

It has been stated as the intent of Congress, by the enactment of compulsory licensing measures, to provide means whereby the small manufacturer may compete with the large industrial concerns. It has been particularly pointed out that under such measures the small manufacturer may obtain a

license under the patents owned by the large concern and thereby enter into competition with the large concern.

### Would Not Aid Small Manufacturer

Obviously, such a condition could exist only in theory. The small manufacturer is limited to the production of goods in small quantities, and to the production of only a few types of goods; therefore, his costs of production are higher than those of a large concern having facilities for mass production of many items. Many other factors, such as the relative inability of a small manufacturer economically to purchase modern automatic mass production machinery, his limited personnel of engineers and research men, and his limited capital, enter into the determination of the cost of production by the small manufacturer and curtail his ability to compete with the large concerns.

If the small manufacturer owns the patent under which a large concern seeks a license according to the provision of the compulsory licensing measures, it would manifestly be unwise for him to make large expenditures of time and money in the development and perfection of his patented article or on research to improve his methods of manufacture. Even though the small manufacturer would receive a royalty from the large concern, the large concern, by virtue of its mass production techniques and sales force, could produce and sell the article at a fraction of the cost entailed by the small manufacturer and thus be able to obtain all the business.

For example, assume that a small manufacturer of oil-field specialties has been steadily developing new tools. Thousands of dollars have gone into design, research, and development costs. When the new tools are put on the market, a reasonable price must be charged, the quality must be good, and the tools must be useful, or no oil producer will buy them. Accordingly, the costs of research, design, and development are added to the costs of manufacture and the total is spread over the period during which the manufacturer would ordinarily expect to enjoy the exclusive rights to his invention under his patents.

Of further serious concern to the small manufacturer is the possibility that, under a compulsory licensing system, the large concerns might make use of the well known "squeeze play." After taking a compulsory license under the small manufacturer's patents, the large concern might sell the patented article at a price lower than that at which the small manufacturer could sell and remain in business. Thus, the small manufacturer would be threatened with insolvency if he attempted to continue to compete. By these tactics, a small manufacturer could be forced out of business or into the fold of the large concern.

There is also another important factor to consider. A small manufacturer, who builds a patented oil-field specialty item in which quality materials and precision workmanship are prime requisites, would have the industry's faith in his product and the value of his patent materially damaged by a competitor who sold an inferior tool manufactured under a compulsory license.

If a competitor could come in and obtain a compulsory license on a small royalty basis, then the small manufacturer who owns the patents would have to compete with a manufacturer who had had no development, design, or research costs to add to his manufacturing costs. Under such a system the developer of new manufactures and useful arts is penalized by the very measure designed to give him relief.

### Research and Development Penalized

Under compulsory licensing plans of the types that have been presented in the past, research and development would be penalized and stifled. No small manufacturer could afford to spend time and money in research and development only to have a competitor receive a compulsory license under his patents and be able to compete under more favorable conditions than were available to the developer.

The position of the small manufacturer of oil-field specialties was succinctly stated by Dudley Sharp of the Mission Manufacturing Company of Houston, Texas, before the House Committee on Patents in 1938:

"We do not believe that in our small company the compulsory licensing of patents would in any way help employment or progress or the limiting of the activities of the larger corporations as against the smaller ones.

"... Due to the protection of this patent, which we purchased along with others which we purchased on other articles, we have been able to build up a fairly secure volume of business. I mean it is ample enough to pay our 100 men well, keep them working steadily....

"Gentlemen, we are definitely against any kind of licensing of patents which will take away the only protection that we little men have against these big corporations."

It was stated by the chairman of the Temporary National Economic Committee, Senator O'Mahoney of Wyoming, on January 24, 1939, that "... inventors and business still need the protection and stimulation of patents. The fact that patents are keystones in many industries has been brought home to us with great emphasis. I doubt whether I had realized their significance as a primary force in the operations of the economic system.... There was practically unanimous agreement among the witnesses that Congress, by the enactment of the patent law, has given this country a system far superior to that which exists in any other country."

### Careful Deliberation Essential

It is generally recognized that, like any human institution, our patent system is the proper subject of improvement. It is urged, however, that any permanent and sweeping revision of our patent laws be held in abeyance until such time as careful deliberation, in the absence of a period of national stress, can be undertaken of the full aspects and imports of any such change.

We must, in the aftermath of this war, look forward to the encouragement of invention, as the incentive to scientific improvement and the development of the useful arts, or we shall have defeated the principles for which we are fighting.

The reopening of petroleum development, the efficient production of petroleum, reconstruction of demolished oil-field facilities and equipment, and the full utilization of our petroleum technology will require the exercise of the petroleum industry's best inventive efforts. We must not be penalized by measures that suppress and stifle research, design, and development.

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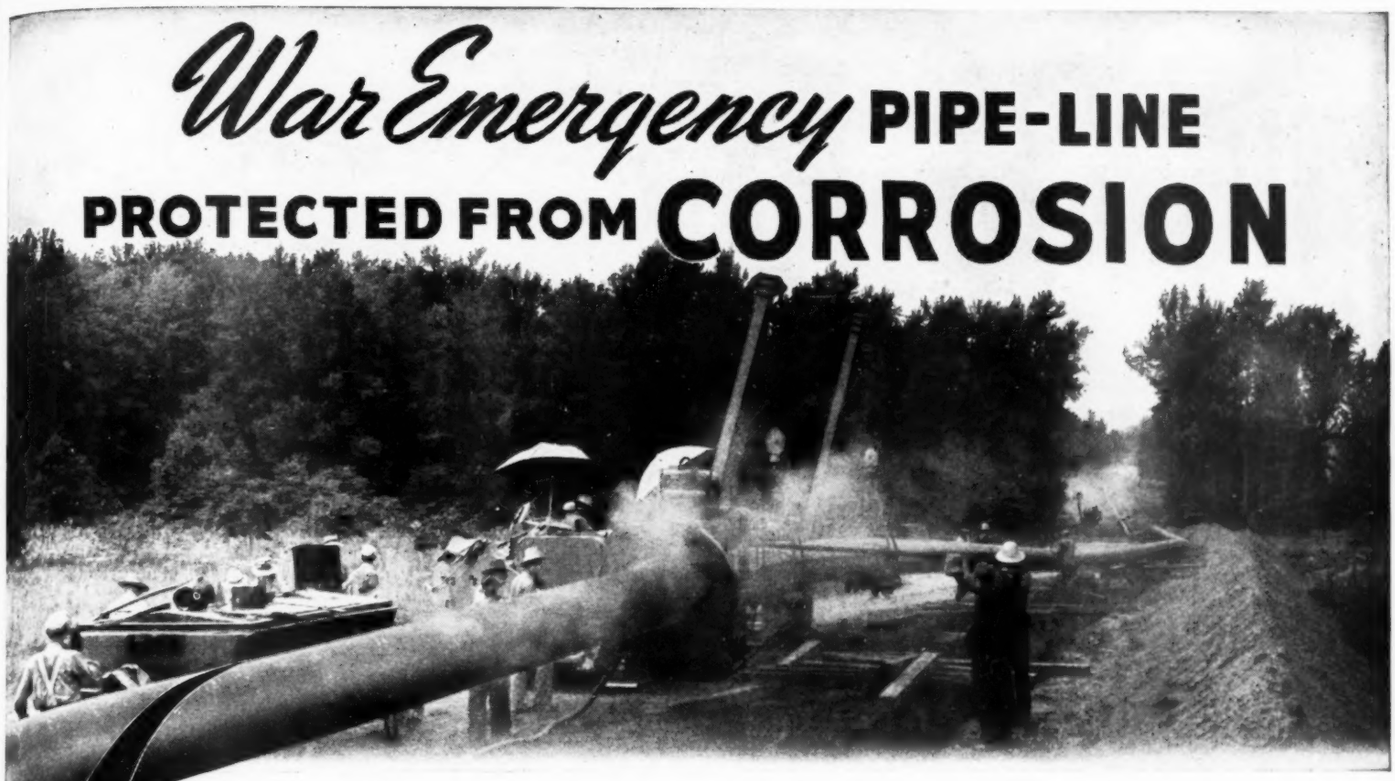
# *War Emergency* PIPE-LINE PROTECTED FROM CORROSION



**The new emergency pipe-line, now under construction from Longview, Texas, to Salem, Illinois, is estimated to carry 300,000 barrels of crude oil per day. It is the largest diameter, major line carrying crude oil ever built and will establish records both for size and speed of construction.**

## *Carey* ASBESTOS PIPE-LINE FELT

**To protect the steel pipe from corrosion, it is coated and wrapped mechanically with rust-proof materials, including Carey Asbestos Pipe-Line Felt. On this project, Carey Felts were wrapped by Carey machines leased and serviced by Perrault Bros., Tulsa, Oklahoma.**

**If you have a problem involving the permanent protection of underground pipe, you can profit by the use of CAREY'S experience in this field. A nation-wide engineering and service organization is at your command. Write Dept. 88 for details.**

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# Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

## Manufacture of Lubricating Oils

### Class Meeting No. 5

NOTE: Throughout the class proceedings, no attempt is made to distinguish the identity of the pupil speaking. When a series of remarks is made by pupils it usually denotes an interchange of discussion among the class members themselves.

*Leader:* Each group has prepared to put on the board a flow sheet showing their idea of a propane solvent process to dewax and deasphalt a residuum from Oklahoma City crude oil. This material can be similar to that charged to the vacuum unit. Show temperature and pressure at points important from the viewpoint of processing. Quantity 2500 bbl. per day of residuum. I suggest that each group work together and all five groups put on the board their propane processes and then we will have the individual discussions.

Group One, would you like to discuss yours now?

*Pupil:* We used a model for our process. The process was developed by the Shell Oil Company and put in operation at their Wood River refinery in about 1936. This process was developed by Shell in conjunction with the M. W. Kellogg Company. Due to limited space, we have omitted the propane flow. We are taking residuum from the atmospheric unit into an asphalt settler and blending four volumes of propane with one of residuum. This asphalt is taken from the bottom into an asphalt washer and fresh propane added. The propane layer is recycled back to the settler. The bottoms from the washer are passed into an asphalt still where propane is flashed-off and about 3½ percent of asphalt is removed, which has a melting point of 170-200° F. We believe that asphalt could be blended with fuel oil. Referring back to the asphalt settler—propane is coming overhead with the upper layer of oil and propane mixture. The total volume of propane and oil passing with the propane separator, will be in a ratio of 2 of propane to 1 of oil. From there it goes to an oil solution tank, which is a surge tank. Then the oil passes to the chillers of which there are three normally. The ratio is about 2½ to 1, and the temperature approximately minus 40° F. This is accomplished by self-evaporation. Then the rotary type filter is used. It is asserted that about 2½ to 3 gal. per sq. ft. of filter surface and 2 to 10 lb. pressure differential will be gained; normally the filter operates at about 4 lb. drop. We were unable to find at what pressure they operated, but someone suggested about 50 lb. One interesting point is that in order to pump the petrolatum from the filter, it was found necessary to add propane to slurry it, the slurry being taken to the petrolatum still, which operates at about 300°F., and here excess propane is flashed off. Acid has not yet been added. The dewaxed solution is discharged from the filter to the dewaxed solution still where propane is flashed off. This still is operated at 300°F. with steam as the heating medium. We plan on discharging the product to a fractionating column where by careful fractionation we believe we can separate the neutrals from the bright stock. We would then contact with acid not to exceed 15 lb. per barrel to end up on the contact filters.

*Pupil:* I should like to ask a question. Why contact if you deasphalt in the beginning?

*Pupil:* Due to the fact that in the propane processes it has been found necessary to use acid, we would not have an asphalt-free oil, probably because of some trouble in oxidation. We thought we should finish up in the manner mentioned.

*Leader:* What happens to the viscosity index number when you use propane to deasphalt? Is it improved or lowered?

*Pupil:* It is lowered.

*Leader:* Then you may help it some with the acid.

*Pupil:* Yes.

*Leader:* What is the reason for that? Why do you lower it by deasphalting? What have you removed?

*Pupil:* We have removed some of the heavier lube oil constituents with this asphalt.

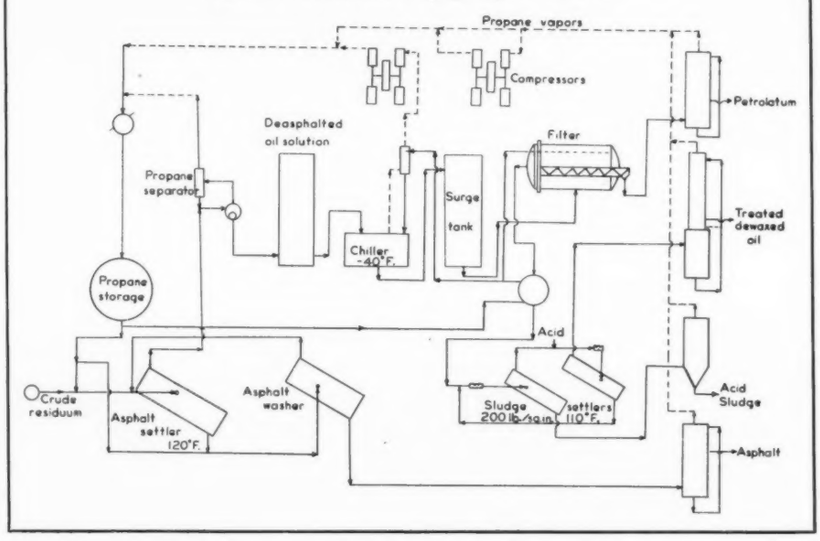
*Leader:* When the heavier lube oil is balanced off, isn't that where the viscosity index number drops? There is another phase also—to solvent-refine completely to increase the viscosity index number. Is there something else you want to get out of that oil that you did not get out with the propane?

*Pupil:* Yes, resins.

*Leader:* How about some of these low viscosity index naphthenic oils?

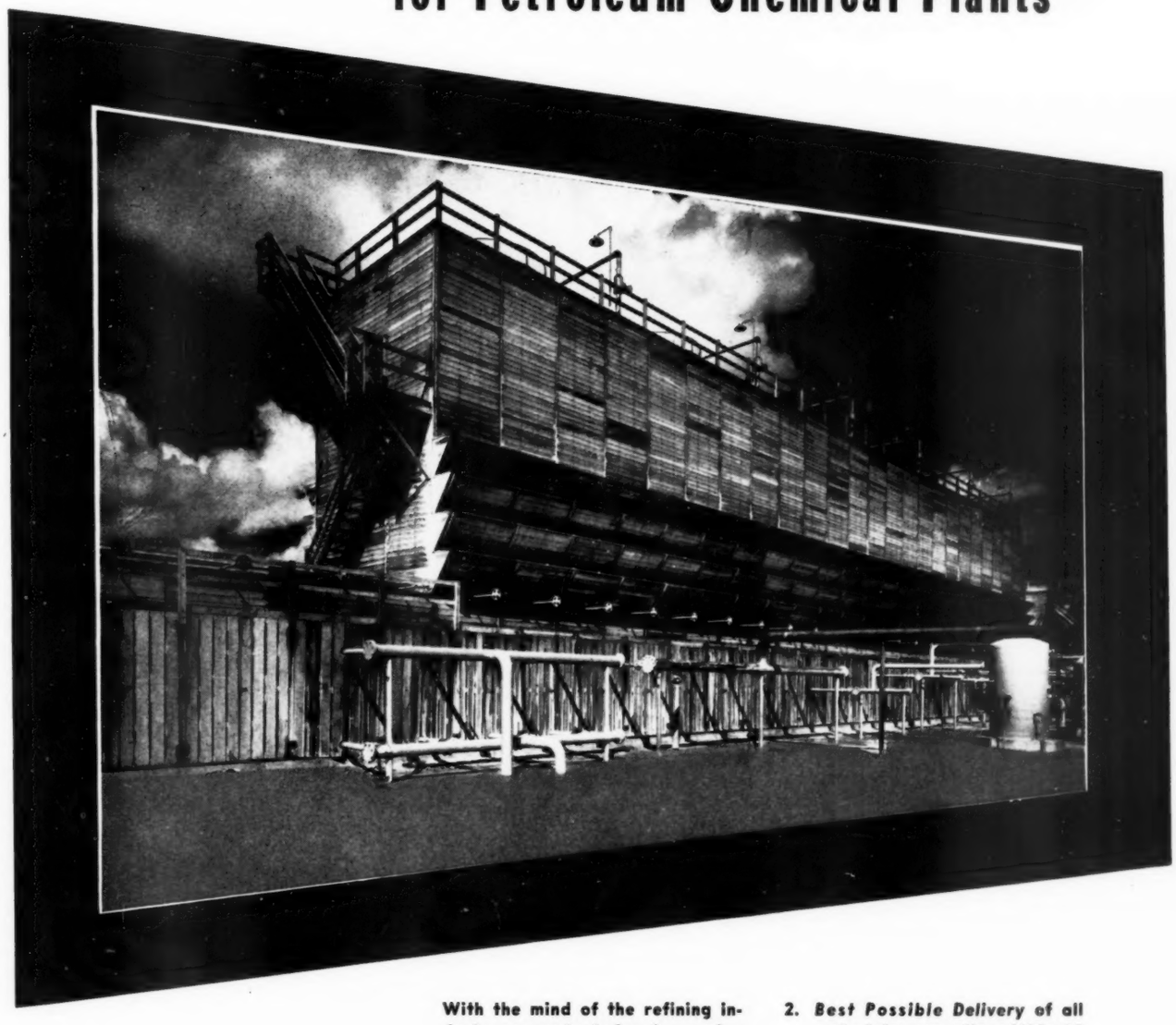
*Pupil:* They will not separate except with acid or something else that will

*Fig. 5. Process used by groups 1 and 3*



# Fast Delivery and Erection of HUDSON COOLING TOWERS

## for Petroleum Chemical Plants



Above—Hudson Induced Draft Cooling Tower, designed for use with cooling sections in base, at the La Gloria gas processing plant.

**With the mind of the refining industry concentrated on increasing the output of aviation gasoline, synthetic rubber bases, alcohol, toluene and other products essential to war—Hudson is ready with:**

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attack them. Propane is not strong enough to precipitate naphthenes.

*Leader:* Yes, so probably we shall all contemplate using some acid.

*Leader:* Well, it is commonly used.

*Pupil:* They stated they acid-treated before filtering. Asphalt acts as a filter aid and helps remove the cake from the filter better.

*Leader:* Asphalt is a nucleus around which the paraffins gather.

*Pupil:* The ratio is 4 to 1 and a part of the residuum is removed, then the ratio drops. I don't understand the mechanics of that.

*Pupil:* The way I interpret it is that the propane is drawn over into the asphalt wash room and the overhead—the article mentions that the upper layer of oil in the settler has a ratio of 2½ to 1—is carried over to the asphalt washer, and additional fresh propane is added in this particular instance to try to salvage any overhead, which is termed recycle.

*Pupil:* Then would the bottom layer in the settler have a ratio of 6 to 1 propane to your asphalt?

*Pupil:* That would depend on the percentage of asphalt in your lube.

*Pupil:* You are going to take over some good oils into your asphalt washer that, in turn, through the introduction of fresh propane, will be washed over into the settler.

*Pupil:* What percentage of propane comes off the still from the washer?

*Leader:* I can't answer; I didn't study that particular process.

*Pupil:* They did not balance out the propane so I am afraid I can't say any more about it. I will read something here, however, taken from our text:

"Due to the commercial importance of the propane process most of the available information concerns application of this particular substance to the refining of mineral oils. Recent developments along these lines are summarized by Wilson, Keith and Haylett, who point out the following characteristic properties of propane when applied as a solvent for mineral oils within certain temperature ranges:

"(1) The higher the temperature, the less is the solubility of oil in propane,

"(2) The more propane is added to an asphalt bearing oil, the less asphalt is dissolved,

"(3) Pressure has a large effect on solubility,

"(4) Compressed propane gas will, at certain temperatures, dissolve more oil than liquid propane at slightly lower temperatures and pressures."

*Leader:* That is just purely a blending-off operation.

*Pupil:* Would it not be more economical to have your fractionating column before refrigerating to minus 40°F. and instead of chilling the entire lube fractions to minus 40°F., couldn't you get by with minus 10°F. on 50 percent of it? Wouldn't that enter into the picture from an economical standpoint?

*Pupil:* I should not think so. I think it would be easier to filter the entire residuum. Refrigeration is very economical and occurs by evaporation of the propane. It is the recovery of the propane that is the expensive item.

*Leader:* In what manner is propane recovered?

*Pupil:* By compression.

*Pupil:* Did it say in that article how much propane loss there was in the system?

*Pupil:* The fact is mentioned that there were a few minor leaks.

*Leader:* I have talked with several persons who have had something to do with these processes and they all say that the losses are negligible.

*Pupil:* The article says 95 percent of the propane had been recovered up to the time the oil went to the depropanizer after it was dewaxed, so the loss would be less than 5 percent.

*Pupil:* It couldn't be that much, because we figured the price of propane, and propane is quite costly.

*Pupil:* It is about 6 cents per gal.

*Pupil:* It is not meant that you would lose 5 percent—but the loss would be in that 5 percent.

*Pupil:* Ninety-five percent was rerecovered before it went to the depropanizer—you would have additional recovery.

*Leader:* There will be some non-condensible gases coming out of this activity in some manner and that is part of the loss. It is customary to pick it up and use it for furnace gas. That is one of the things you have to take care of in practical operation.

*Leader:* Yes. Is Group 2 ready?

*Pupil:* Yes. This is a process developed and used by the Standard Oil of Indiana at the Whiting plant and they operated on a short residuum from Mid-Continent crude oil. I think that their residuum has probably had wax distillate taken off.

*Leader:* Did they show the gravity of it?

*Pupil:* Eighteen, I think. The residuum is passed through a pump and mixed with liquid propane from storage, about 3 to 3½ parts propane and 1 residuum in an orifice mixer. It is run into an asphalt settler and asphalt taken off the bottom and run through an asphalt reducing and recovery plant, then mixed with gas-oil so it can be settled. Propane is taken off and picked up by a propane compressor. The deasphalted oil goes from there into a mixer. In order to dry this oil it is subjected to two-stage acid treatment. Sludge is taken from the last stage and mixed and dried. They thought it might be necessary to have a dehydrating acid treat and said they were gratified by it because they had to use only about one-half as much acid as laboratory work had indicated. We estimated they used 20 lb. per bbl. of acid, which is not very much for a residuum stock. This goes into a sludge settler and is afterwards mixed with a second acid sludge, the oil then goes through the mixer with 93 percent acid. The weaker acid did not give the cast they wanted and 98 percent did not show any more efficiency than the 93 percent, so they used the 93 percent. This is all under 200 lb. pressure. Provision was made at this point for flashing off some propane should the acid cause the temperature to rise above 110°F., but it did not ever have to be used because the acid treatment did not cause any rise. This goes to a second settler and the acid is recycled and re-used. After the acid sludge settles out, the acid-treated oil goes through a caustic mixer and the caustic is settled out in drums similar to asphalt drums. They were using it in connection with cold settling. They said they could use propane dewaxing, but they used cold settling. To make the process complete, we used the propane dewaxing system as shown in the Refinery Catalog, and according to this source, after deasphalting, the propane ratio will be about 3½ to 4. Then after acid treating (we don't know what it would be, but it should be over 4 percent, which will give you a chance to chill by evaporating the propane) we believe approximately 2½ to 3 volumes of oil is required for dewaxing. We introduced propane at this point for mixing in case there is not enough propane after the dewaxing. The chilled oil goes into a filter storage tank and from there into the rotary filter. It would have to be at a fairly high pressure because there is a propane washing system on the filter and the product is pumped directly from the propane storage. No temperatures were shown, but we estimated it would be about minus 25°F. to make a zero oil. The oil goes from there to the strippers and is stripped of the propane. Both the acid sludge and asphalt are stripped of propane; provision is made for running spent caustic into a small drum where it is mixed with the acid sludge for neutralizing. We don't know whether a sludge burning system would be necessary in our plant, as our sludge is burned in plant furnaces.

EDITOR'S NOTE: Class Meeting No. 5 will be continued.

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# Thermo-Siphon Heaters For Oil-Field Operations

## ☆ Their practical application to definite oil-field problems

*by Harold Vance,* Head, Petroleum Engineering Department

and

*Elmer G. Smith,* Professor of Physics, A. and M. College of Texas

HAROLD VANCE

ELMER G. SMITH

***In the September issue of THE PETROLEUM ENGINEER the writers discussed the design of the thermo-siphon heater and explained an application of this heater to keep an oil and gas separator warm. Data regarding heater design and methods of calculation were also a part of this first article.***[1]

PROBABLY the most common application of the thermo-siphon heater has to do with the application of heat to the flow tank or gun barrel for the purpose of breaking down emulsions. The principles previously discussed apply to this type of heater. Fig. 1 shows this application. In connection with any problem of heat transfer the amount of surface of contact, the nature of the material through which the heat is transferred, the turbulence, and the difference of temperature between the hot and cold materials determine the rate of heat transfer.

In a gun barrel installation, where the oil to be heated is floating on top of a body of hot water, the area of contact is equal to the cross-sectional area of the tank containing the two liquids. Thus, we find that the diameter of the tank is the controlling factor, provided that the difference in temperature between the oil and the water is the same. In order to increase the surface of contact one may install in the ordinary gun barrel what the writers have termed an emulsion pre-heater, which consists of coils very similar in design to steam coils used in heating oil with steam. The oil from the well passes directly through these coils, which are in turn covered with hot water; then the oil is discharged through an enlarged pipe section into the body of the oil itself. This problem of surface contact is directly responsible for the low heat transfer possible in a small oil and gas separator. We are not only confronted with the problem of heat transfer between the water circulating through the thermo-siphon and the oil in contact with it, but also with that of the dissipation of heat contained in the water and in the oil caused by the amount of tank surface exposed to the air. The transfer of heat from a standard steel tank to air with a 20 mi. per hr. wind is about ten times as fast as from a standard wooden tank under the same condition. Therefore, as regards the conservation of heat, it is evident that a tank constructed of material that does not readily transfer heat to the atmosphere would be most suitable. There is also a heat loss in the thermo-siphon heater and a heat loss through the lines connecting the heater and the tank. Therefore, the heat delivered to the oil in the tank equals the heat generated in the heater, less the heat lost in the heater, less the heat lost through the lines, less the heat lost through the surface of the tank. We should then expect the most efficient type of heater to be one in which both the heater itself and the water lines from the heater to the gun barrel are well insulated, and in which the gun barrel is equipped with an emulsion pre-heater.

### Heat Losses Between Heaters and Gun Barrel

The heat loss between the heater and the gun barrel may be determined by the following formula:

$H = C \times A \times T$ . . Equation (1)

In this equation:

C = the number of B.t.u. that are transmitted in one hour through 1 sq. ft. of exterior pipe surface when the temperature difference between the pipe and the air outside the pipe is 1°F.[2],

[1] "The Thermo-Siphon Heater for Oil-Field Use," by Elmer G. Smith and Harold Vance, *The Petroleum Engineer*, September, 1942.

[2] *Mechanical Engineers' Handbook*, by Lionel S. Marks, 3rd edition, McGraw-Hill Book Company, page 401-402.

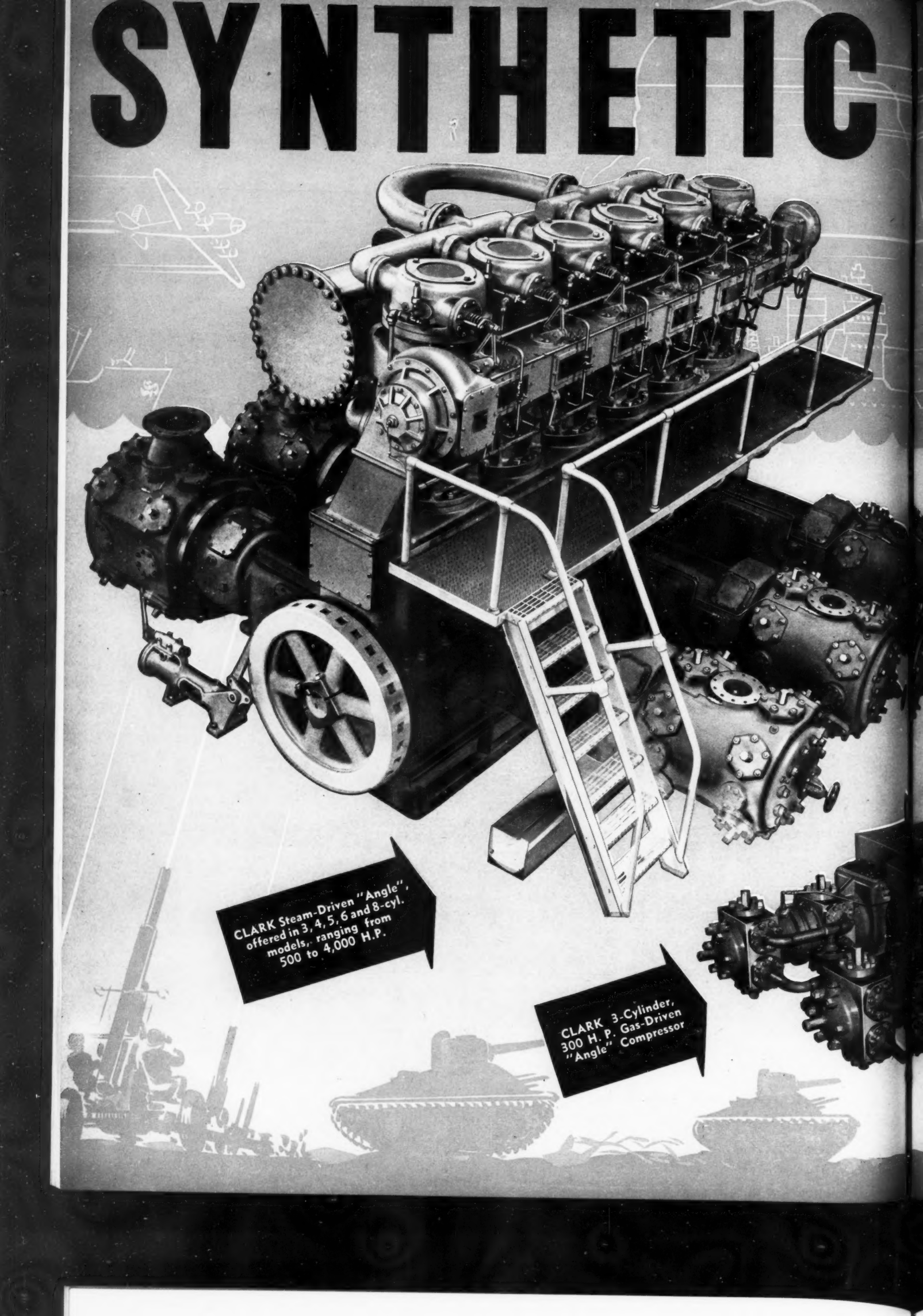
TABLE I

Approximate heat loss from large-diameter uninsulated pipe exposed to 20 mi. per hr. wind

| Pipe temperature, °F. | Air temperature, °F. | B.t.u. per hour for 1 sq. ft. of exposed pipe surface |
|---|---|---|
| 200 | 40 | 1030 |
| 200 | 20 | 1200 |
| 200 | 0 | 1370 |
| 200 | −20 | 1560 |

*(Continued on Page 106)*

# SYNTHETIC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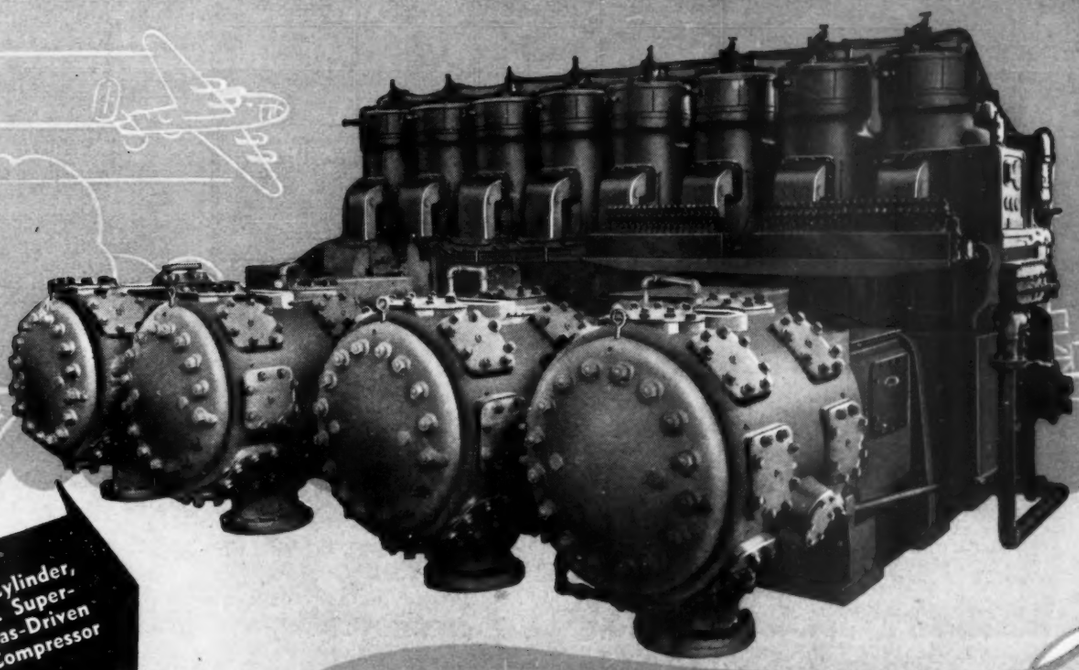

CLARK 8-Cylinder, 1000 H. P. Super-Charged Gas-Driven "Angle" Compressor

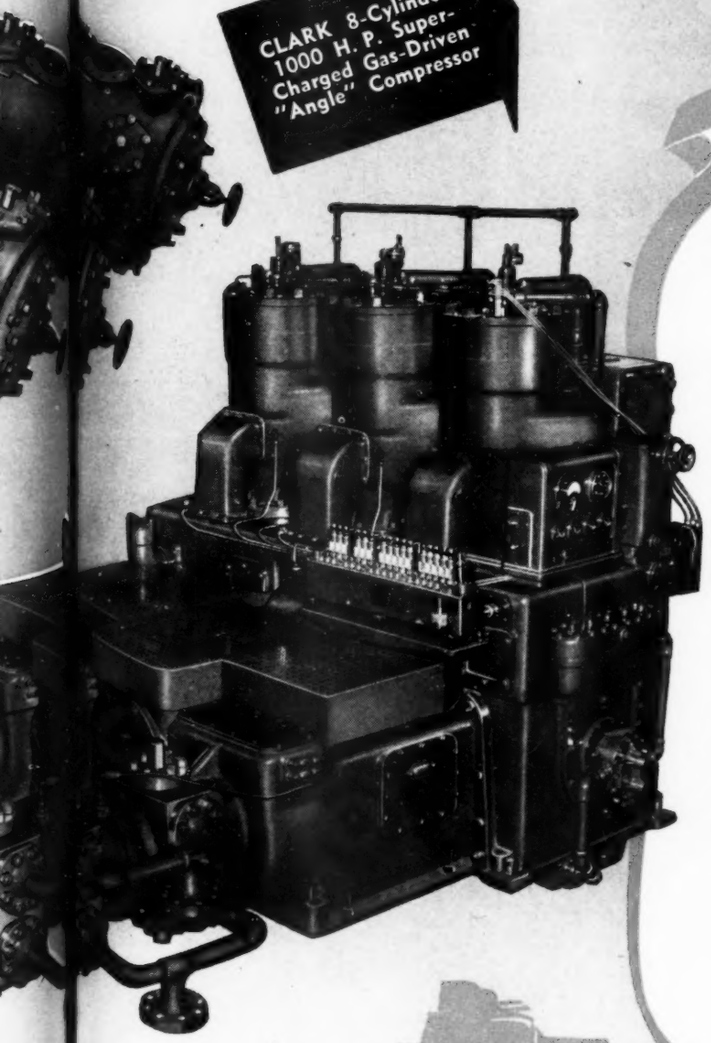

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**TABLE 2**

**Approximate heat loss from uninsulated steel tanks and wooden tanks exposed to a 20 mi. per hr. wind**

| Avg. temp. of fluid in tank, °F. | Air temp. outside tank, °F. | Heat loss in B.t.u. per hour from 1 sq. ft. of exposed tank surface | | | |
|---|---|---|---|---|---|
| | | Uninsulated steel tank | | Wooden tank | |
| | | From side | From deck | From side | From deck |
| 170 | 40 | 647 | 196 | 59 | 48 |
| 170 | 20 | 769 | 235 | 68 | 57 |
| 170 | 0 | 895 | 277 | 78 | 65 |
| 170 | —20 | 1027 | 322 | 86 | 73 |
| 170 | —40 | 1173 | 371 | 96 | 82 |

**Example of the use of above table:**

A high 500-bbl. steel tank has 780 sq. ft. of surface in the sides and 190 sq. ft. of surface in the deck; therefore, with the average temperature of the fluid in the tank at 170°F. and the outside air temperature 40°F., the heat loss from the sides of the tank in B.t.u. per hour is 780 × 647 or 504,660. The heat loss from the deck equals 190 × 196 or 37,240 B.t.u. per hour. The total heat loss from the tank under these conditions is the sum of the loss from the sides plus the loss from the deck or 504,660 plus 37,240 or 541,900 B.t.u. per hour.

*(Continued from Page 103)*

A = the outside surface area of the pipe in sq. ft., and

T = the difference in temperature between the pipe and the air outside the pipe in degrees Fahrenheit.

Table 1 was computed from Equation (1), using appropriate values for C.

By moderately heavy firing one may transfer 8000 B.t.u. per hour to 1 sq. ft. of pipe surface in the heater. Reference to Table 1 shows that even when the outside temperature is 40°F., the heat loss from the lines between the heater and the tank may be 1030 B.t.u. per hour for 1 sq. ft. of pipe surface. Therefore, one would have to have 1 ft. of pipe in the heater to compensate for the heat loss in 8 ft. of pipe outside the heater.

It is evident that this loss would necessitate the use of a large heater, and some method of insulating the pipes between the heater and tank should be used. An inexpensive and satisfactory method of insulating the pipes is to cover them with dry earth. The earth must be kept dry, and an inexpensive method of doing this is to cover it with asphalt paper, which can be held in place by covering the paper with another layer of earth.

## Heat Losses from Fluid in Gun Barrel to Atmosphere

An uninsulated steel tank loses heat almost as fast as an uninsulated steel pipe. The heat loss is governed by the same factors, but is slightly less because of the large diameters in case of tanks. Table 2 shows the heat losses in B.t.u. per hour for 1 sq. ft. of tank surface on the sides and deck for a steel tank and for a wooden tank.

Table 2 illustrates the relative heat-insulating properties of wood over steel. The heat loss from the sides of a tank amounts to 90-96 percent of the total heat loss from the tank. A steel tank can be easily insulated with wood on the sides. It would be almost as effective against heat loss as a tank constructed entirely of wood. Care should be taken to prevent water from entering the space between the wood insulation and the tank.

## Transfer of Heat from Hot Water to Oil

The ultimate purpose of heating the water in the heater is to transfer the heat to the oil in the gun barrel. The writers have already discussed the various heat losses in the system and have mentioned that the heat that can be transferred to the oil is governed by the area of contact between the water and oil in the gun barrel.

### Determination of amount of heat required to raise temperature of 1 bbl. of oil 1°F.:

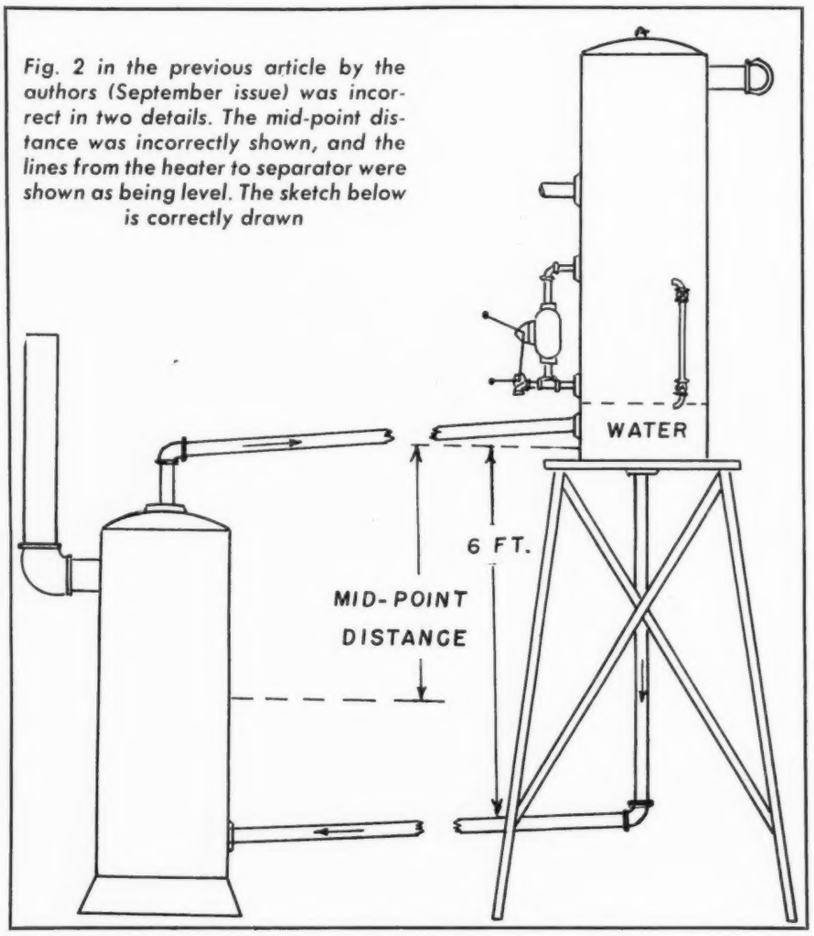
The specific gravity of 31-deg. A.P.I. oil is 0.87 and the specific heat of the same gravity oil is 0.5; therefore, the volume specific heat of this oil is 0.87 × 0.50 or 0.435, which means that it will take 43.5 percent as much heat to raise the temperature of 1 cu. ft. of oil 1°F. as it would to raise the temperature of a cu. ft. of water 1°F. As there are 5.62 cu. ft. in a barrel of oil and water weighs 62.43 lb. per cu. ft.:

$$5.62 \times 62.43 \times 0.435 = 152 \text{ B.t.u.} \quad \text{Equation (2)}$$

Therefore, 152 B.t.u. are required to raise the temperature of 1 bbl. of 31-deg. A.P.I. oil 1°F. Knowing the number of B.t.u. required to raise the temperature of 1 bbl. of oil 1°F. and the number of B.t.u. transmitted per sq. ft. of surface contact between the oil and hot water, we can calculate the number of barrels per hour that can be heated under a given set of conditions.[3]

[3] *Heat Transmission*, William H. McAdams, 1st edition, McGraw-Hill Book Company, page 145.

*Fig. 2 in the previous article by the authors (September issue) was incorrect in two details. The mid-point distance was incorrectly shown, and the lines from the heater to separator were shown as being level. The sketch below is correctly drawn*



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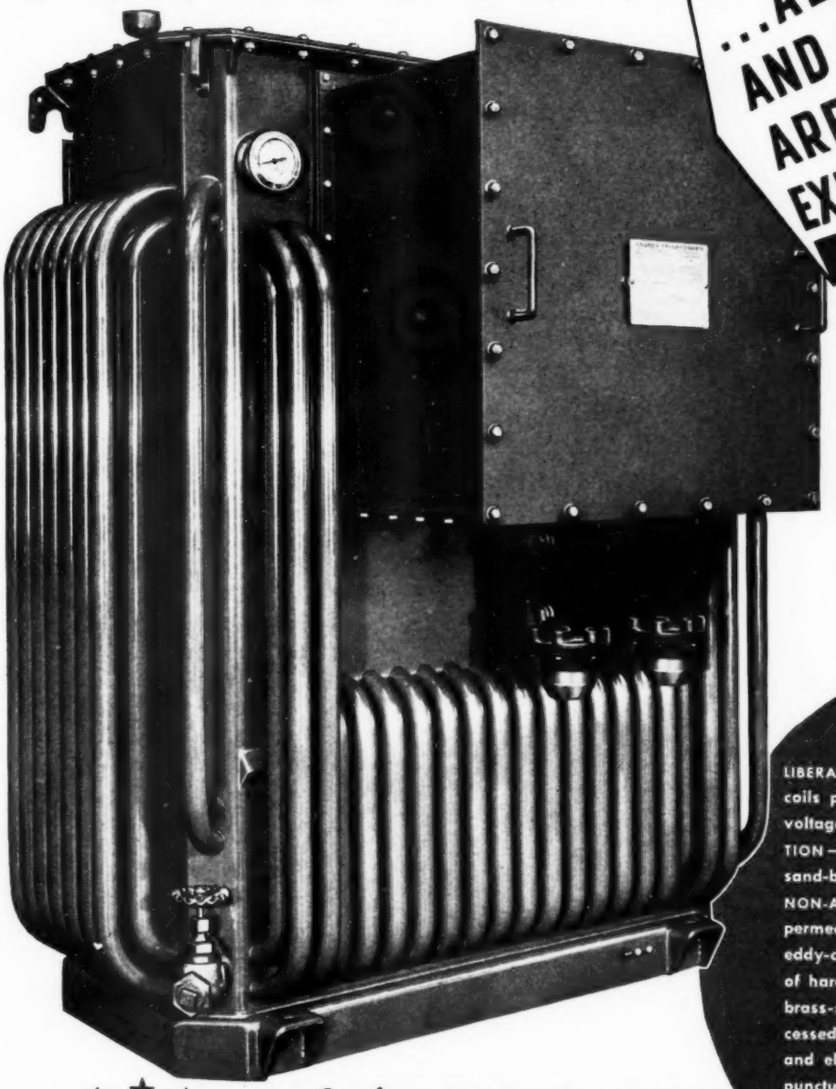

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**TABLE 3**

**Heat transmitted to the oil per sq. ft. of contact between oil and water for counter flow (see Fig. 1) with water entering at 190°F. and leaving at 150°F. with final oil temperature of 170°F.**

| Temperature of incoming oil, °F. | B.t.u. per hour transmitted through 1 sq. ft. of contact surface |
|---|---|
| 50 | 588 |
| 30 | 658 |
| 10 | 725 |
| −10 | 793 |
| −30 | 858 |

For a high 500 bbl. wooden tank the area of the oil-water surface is 201 sq. ft. Therefore, heat transmitted through the oil-water surface is 201 times the figure in the right-hand column of Table 3 for oil entering at 50°F.:

$201\ (588) = 118{,}200$ B.t.u. per hour . . . . . Equation (3)

The oil is at the same time losing heat through the side of the tank, however. As oil fills only the upper ⅔ of the tank, this loss equals ⅔ of the loss from the sides of the tank. From Table 2 for 40°F. air temperature (which corresponds to 50°F. entering oil temperature) column 5 gives B.t.u. per sq. ft.

The area of the sides of a high 500 bbl. tank is 804 sq. ft. Consequently the upper ⅔ of the sides of this tank will lose:

$⅔\ (804)\ 59 = 31{,}600$ B.t.u. per hr. . . . . Equation (4)

By subtracting the values given in Equation (4) from that in Equation (3), we obtain

$118{,}200 - 31{,}600 = 86{,}600$ B.t.u. per hr. . . . . Equation (5)

which is the number of B.t.u. per hr. that are effective in heating the oil.

From Equation (2) it takes 152 B.t.u. to heat 1 bbl. of oil 1°F. Therefore, the number of barrels per hour that can be heated from 50°F. to 170°F. in the tank are:

$$\frac{86{,}600}{152\ (170-50)} = 4.75 \text{ bbl. per hr.}$$

. . . . . Equation (6)

In order to determine the heat to be supplied to the tank, the heat lost from the lower ⅓ of the tank must be added to the heat transmitted through the oil-water surface. From the data in equations (3) and (4):

$118{,}200 + ⅓(804)59 = 134{,}000$ B.t.u. per hr. . . . Equation (7)

The method of determining the size of thermo-siphon to supply this heat was given in a previous article.[1]

## Emulsion Pre-heaters

An emulsion pre-heater will increase the heating capacity of any installation if the heater is capable of delivering the required amount of heat. The purpose of the pre-heater is to increase the area of contact between the hot water and the oil.

If one wanted to increase the heating capacity of a certain installation, he could double the capacity by installing a pre-heater having a surface area equal to the cross-sectional area of the tank, but he would also have to increase the capacity of his heater to take care of the added heat absorbed by the oil. Otherwise, the tank would be able to transmit more heat than the heater was capable of supplying to it.

## Design Procedure

A summary of the procedure used in designing a thermo-siphon heater as applied to wooden gun barrel installations is as follows:

For each tank, the area of the oil-water surface was determined. Next the number of B.t.u. per hour that this surface could transmit under the given

**TABLE 4A**

**Design data for wooden tanks without emulsion pre-heaters**

**For simple heaters with 2 water pipes and 1 chamber**

To increase the temperature of the oil from 50°F. to 170°F. when the outdoor temperature is 40°F., with a 20 mi. per hr. wind.

| Diameter of tank, ft. | 8 | 10 | 10 | 12 | 16 | 16 | 16 | 22 |
|---|---|---|---|---|---|---|---|---|
| Height of tank, ft. | 16 | 16 | 20 | 20 | 16 | 20 | 24 | 16 |
| Nominal capacity of tank, bbl. | 135 | 200 | 255 | 380 | 500 high | 660 | 790 | 1000 |
| Capacity in bbl. per hour of emulsion | 0.76 | 1.44 | 1.17 | 2.02 | 4.75 | 4.31 | 3.87 | 9.90 |
| Minimum size of water pipe, in. | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 |
| Number of linear ft. of water pipe in furnace | 8.9 | 14.0 | 14.6 | 13.5 | 22.3 | 23.0 | 23.7 | 30.7 |
| Length of furnace chamber, ft. | 5½ | 8 | 8½ | 8 | 12½ | 12½ | 13 | 17 |
| Width and depth of furnace chamber, in. | 12½ | 15 | 15½ | 18 | 23 | 23½ | 24 | 31½ |
| Chimney diameter, in. | 6 | 7½ | 7¾ | 9 | 11½ | 11¾ | 12 | 15¾ |

**TABLE 4B**

**Design data for wooden tanks without emulsion preheaters**

**For simple heaters with 2 water pipes and 1 chamber**

To increase oil temperature from 30°F. to 170°F. when outdoor temperature is 20°F., with a 20 mi. per hr. wind.

| Diameter of tank, ft. | 8 | 10 | 10 | 12 | 16 | 16 | 16 | 22 |
|---|---|---|---|---|---|---|---|---|
| Height of tank, ft. | 16 | 16 | 20 | 20 | 16 | 20 | 24 | 16 |
| Nominal capacity of tank, bbl. | 135 | 200 | 255 | 380 | 500 high | 660 | 790 | 1000 |
| Capacity in bbl. per hour of emulsion | 0.7 | 1.36 | 1.08 | 1.89 | 4.49 | 4.06 | 3.64 | 9.40 |
| Minimum size of water pipe, in. | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 4 |
| Number of linear ft. of water pipe in furnace | 10.6 | 10.5 | 11.0 | 15.3 | 25.1 | 26 | 26.6 | 34.4 |
| Length of furnace chamber, ft. | 6½ | 6½ | 6½ | 9 | 14 | 14 | 14½ | 18½ |
| Width and depth of furnace chamber, in. | 13 | 16 | 16 | 19 | 25 | 25 | 25 | 33 |
| Chimney diameter, in. | 6½ | 8 | 8 | 9½ | 12½ | 12½ | 12½ | 16½ |

**TABLE 4C**

**Design data for wooden tanks without emulsion preheaters**

**For simple heaters with 2 water pipes and 1 chamber**

To increase the temperature of the oil from 10°F. to 170°F. when the outdoor temperature is 0°F., with a 20 mi. per hr. wind.

| Diameter of tank, ft. | 8 | 10 | 10 | 12 | 16 | 16 | 16 | 22 |
|---|---|---|---|---|---|---|---|---|
| Height of tank, ft. | 16 | 16 | 20 | 20 | 16 | 20 | 24 | 16 |
| Nominal capacity of tank, bbl. | 135 | 200 | 255 | 380 | 500 high | 660 | 790 | 1000 |
| Capacity in bbl. per hour of emulsion | 0.64 | 1.27 | 1.01 | 1.77 | 4.30 | 3.86 | 3.44 | 9.00 |
| Minimum size of water pipe, in. | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 6 |
| Number of linear ft. of water pipe in furnace | 11.7 | 11.7 | 12.2 | 17 | 21 | 21.5 | 22.2 | 23.0 |
| Length of furnace chamber, ft. | 7 | 7 | 7½ | 9½ | 11½ | 12 | 12½ | 13 |
| Width and depth of furnace chamber, in. | 14 | 17 | 17 | 20 | 26 | 26 | 27 | 35 |
| Chimney diameter, in. | 7 | 8½ | 8½ | 10 | 13 | 13 | 13½ | 17½ |

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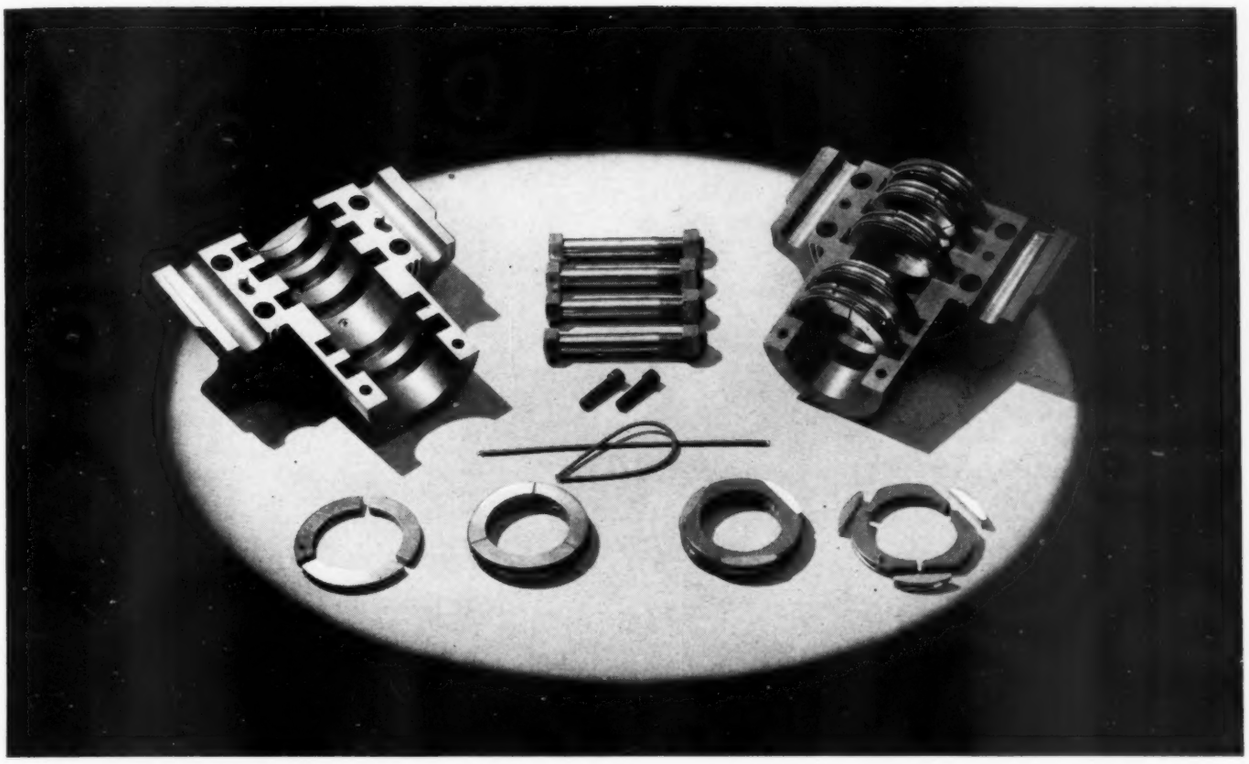

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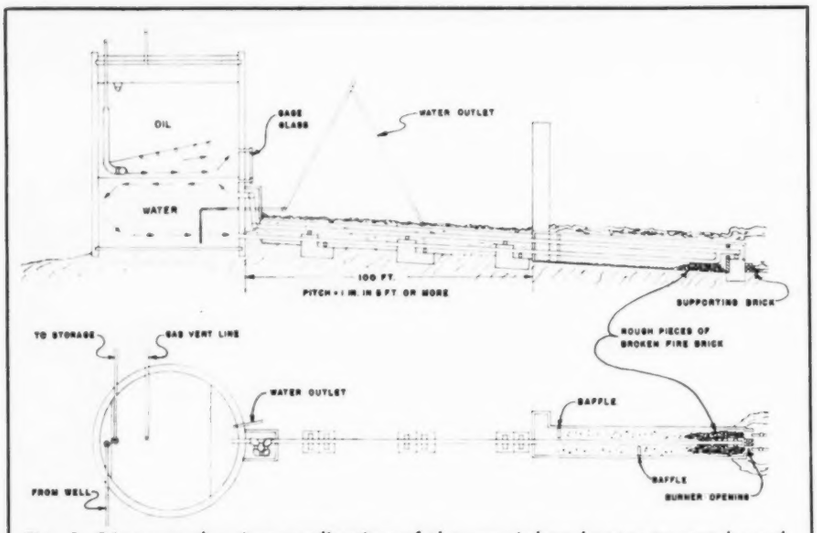



*Fig. 1. Diagram showing application of thermo-siphon heater to gun-barrel installation for breaking down emulsions*

conditions was computed, using Table 2 as illustrated in Equation (3). From this was subtracted the heat loss from the upper two-thirds of the tank giving the heat available per hour to heat the incoming oil (Equations (4) and (5)). Using Equations (2) and (6) the number of barrels of oil that could be heated per hour in that particular tank was determined.

To the number of B.t.u. per hour transmitted from the water to the oil was added the heat loss from the lower one-third of the tank to obtain the total heat to be supplied to the tank as illustrated in Equation (7). The next step was to determine the size of the pipes in the thermo-siphon. This was done by the methods described by the writers in their previous article.[1]

The total heat to be supplied by the heater was finally determined by adding the heat loss from 200 ft. of insulated pipe to the above total. The number of feet of pipe in the heater was determined by assuming that 1 sq. ft. of external pipe surface could absorb 8000 B.t.u. per hour.

**The complete procedure and data for designing thermo-siphon heaters as applied to wooden gun barrels is as follows:**

Table 4 is the complete design for the application of the thermo-siphon heater for gun barrel installations. Fig. 1 illustrates the basic conditions for which these design data were prepared.

Example of use of Tables 4A, 4B, 4C, 4D:

Assuming that the outdoor temperature is 40°F. with a 20 mi. per hr. wind, an oil operator wants to raise the temperature of an emulsion from 50°F. to 170°F., to do so at the rate of 4.5 bbl. per hour using a wooden tank. Using Table 4A, we find in line four from the top the capacity in bbl. per hour of emulsion; in the fifth column to the right we find a capacity of 4.75 bbl. per hour, which is above the desired rate of heating and will therefore be satisfactory. Starting at line one in column five, we find that the tank to use should have a diameter of 16 ft., a height of 16 ft., and a nominal capacity of 500 bbl.; the pipe in the heater and lines from the heater to the tank should be 3 in. in diameter; the heater should contain 22.3 ft. of pipe; the heater furnace should be 12½ ft. long; the furnace chamber should be 23 in. in width and depth, and the chimney should have a diameter of 11½ in.

**TABLE 4D**

**Design data for wooden tanks without emulsion preheaters**

**For simple heaters with 2 water pipes and 1 chamber**

To increase oil temperature from minus 10°F. to 170°F. when outdoor temperature is minus 20°F., with a 20 mi. per hr. wind.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Diameter of tank, ft. | 8 | 10 | 10 | 12 | 16 | 16 | 16 | 22 |
| Height of tank, ft. | 16 | 16 | 20 | 20 | 16 | 20 | 24 | 16 |
| Nominal capacity of tank, bbl. | 135 | 200 | 255 | 380 | 500 high | 660 | 790 | 1000 |
| Capacity in bbl. per hour of emulsion | 0.61 | 1.21 | 0.94 | 1.69 | 4.14 | 3.71 | 3.28 | 8.66 |
| Minimum size of water pipe, in. | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 6 |
| Number of linear ft. of water pipe in furnace | 13 | 12.8 | 13.8 | 18.6 | 22.8 | 23.6 | 24.3 | 28.0 |
| Length of furnace chamber, ft. | 7½ | 7½ | 8 | 10½ | 12½ | 13 | 13½ | 15 |
| Width and depth of furnace chamber, in. | 14 | 18 | 18 | 21 | 27 | 28 | 28 | 37 |
| Chimney diameter, in. | 7 | 9 | 9 | 10½ | 13½ | 14 | 14 | 18½ |

## Conclusions

The writers have presented the complete design data for the use of thermo-siphon heaters for certain oil-field applications. There has been no attempt made to discuss the advantages of methods of treating oil in order to break down emulsions. There are a number of satisfactory methods of doing so, each method having its own particular applications.

☆ ☆ ☆

## Oil Compact to Study Stripper Wells

Strippers, which constitute three-fourths of the producing oil wells of the nation, will be the principal subject for study by the Interstate Oil Compact Commission at its annual organization meeting, to be held December 18 and 19 in the Biltmore Hotel, Oklahoma City, Oklahoma, Chas. L. Orr, secretary, announces.

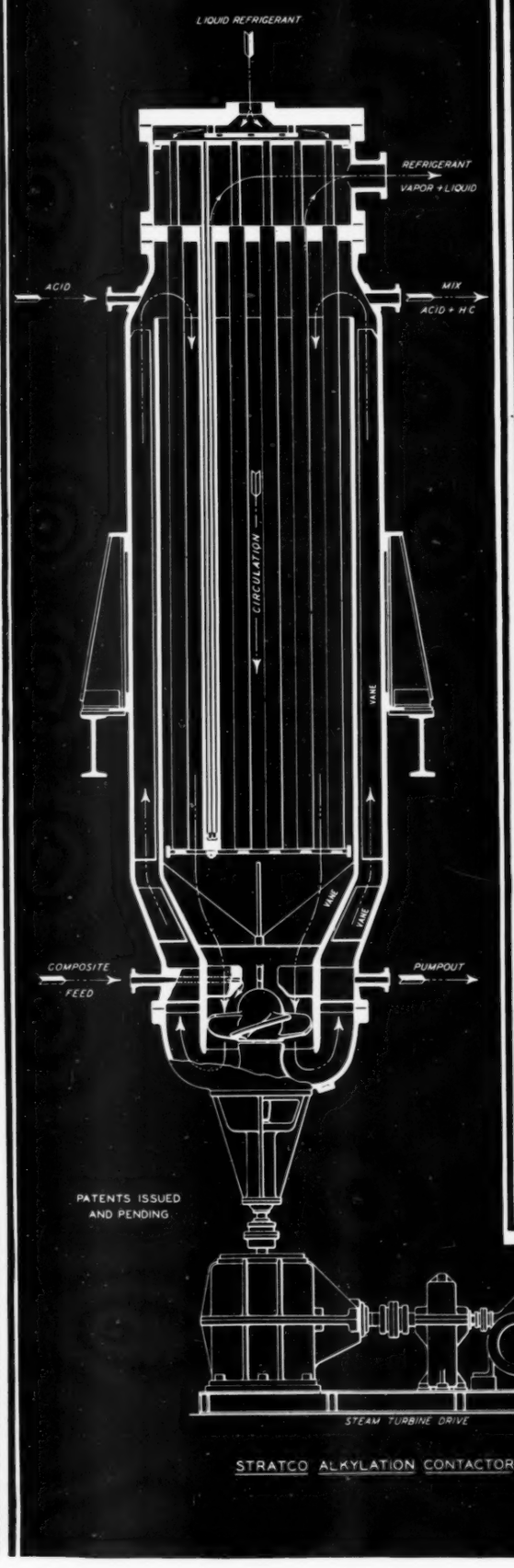
More than 300,000 of these small wells, producing an average of only a few barrels a day, are now being operated with production expenses approximating income. Their continued production is necessary and vital to win the war.

The Compact Commission, through its Research and Coördinating Committee, is coöperating with the National Stripper Well Association in compiling and completing a nationwide survey to be reported at the meeting.

A committee composed of J. C. Hunter of Texas, Hiram M. Dow of New Mexico, P. J. Hoffmaster of Michigan, Harold Ostertag of New York, and N. W. Shiarella of Kentucky, will report and make recommendations for the extension of the Compact, which expires in 1943.

Standing committees are collaborating and will meet together to make joint recommendations for natural gas conservation.

Annual election of officers will be held, committees will be appointed, and plans made for the coming year at the meeting.



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# Gun-Perforated Well Completions

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☆ Study determines optimum number of perforations per foot of casing

*by Benjamin C. Craft*

Professor of Petroleum Engineering, Louisiana State University

IN many Gulf Coast fields gun-perforated completions have become conventional practice. This is especially true when the gas-oil or oil-water contacts are unknown, when the oil saturation is below the top of the sand, and when greater flexibility is desired in re-perforating to exclude gas or water. Other advantages of this method are that it permits the testing of a number of possible productive horizons and permits dual completions.

The study discussed in this article was made to determine the optimum number of perforations per foot of casing, as a guide to engineers and operators. The present practice of some companies is to make sufficient perforations so that their combined area is equal to the inlet area of the screen or slotted pipe. A consideration of inlet areas shows that there are a number of patterns of wire-wrapped screens available: plain drilled, milled groove, standard slotted, double slotted, and ribbed pipe, all these terms referring to the openings in the steel pipe. The wire wrapping that is lugged from top to bottom to provide uniform spacing and bracing of the wires is either square or keystone-shaped in cross-section. There is also variation in the number of slots that are cut either horizontally or vertically on the liner. It is beyond the scope of this article to calculate the inlet areas for each type of wire-wrapped screen and slotted liner; however, Tables 1, 2, 3, and 4 are considered representative and serve as a basis for comparison of the types in use at the present time. The average number of equivalent ½-in. perforations per ft. for a 3-in. liner is 4.9, and for 4-in. is 6.6.

## Pressure Distribution in Sand

It has been demonstrated that the pressure in a sand will vary with the logarithm of the radial distance from the axis of the well, according to the radial flow equation:[1]

[1] *Flow of Homogeneous Fluids through Porous Media*, Ed. 1, by M. Muskat. McGraw-Hill Book Company, 1937, P. 153.

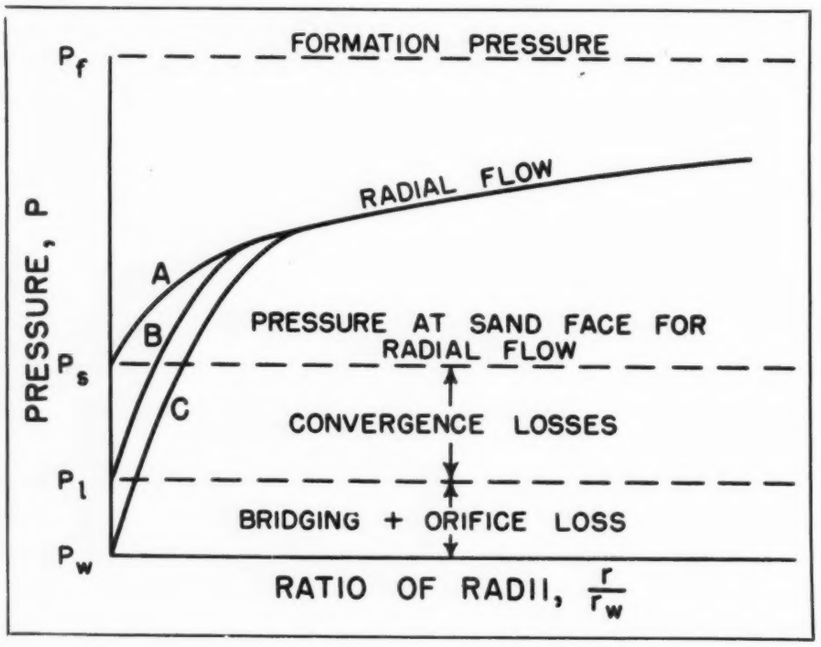


*Fig. 1. Schematic diagram showing pressure distribution near the well bore*

**BENJAMIN C. CRAFT**

is head of the Department of Petroleum Engineering, Louisiana State University—He received an A.B. degree from Stanford University in 1928 and a mining engineer degree from the same school in 1929—Became assistant professor of petroleum engineering at Louisiana State University in 1929, later was made an associate professor, and now heads the department—In addition he has done considerable consulting work and has participated in the activities of numerous technical organizations.

$$P = \frac{Qu}{2\pi kh} \ln \frac{r}{r_w} + P_w$$

where:

$P$ = pressure at the radial distance from the well,
$P_w$ = pressure at the sand face,
$Q$ = rate of flow,
$u$ = fluid viscosity,
$h$ = sand thickness,
$k$ = sand permeability,
$r$ = radial distance from the well, and
$r_w$ = well radius.

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**DRAW WORKS AND DRIVE GROUP:**

1. Maintain adjustments of all friction clutches and replace worn out parts that impair efficient operation.
2. Keep all roller bearings properly lubricated.
3. Make frequent inspection of all positive clutches and shifter mechanisms.
4. Check air control equipment for leaks—connections, lines, valves and compressor unit.
5. Chain and V-belt drives should be systematically inspected for correct tension and alignment. Proper lubrication prolongs chain life.

**ENGINES:**

1. Avoid continuous overloading. It may become necessary to change to smaller pump liners as the well gets deeper.
2. Change crankcase oil at regular specified intervals and use only high quality lubricants.
3. Keep all filters clean.
4. Inspect engines frequently to detect worn or stuck piston rings, valve wear and clearances, and correct immediately.
5. Maintain proper clearances of main and connecting rod bearings at all times.

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In considering the pressure distribution through a gun-perforated completion, reference is made to Fig 1, which gives a schematic diagram of the relative pressure losses for one rate of flow. Curve A shows the pressure loss for radial flow or $(P_f - P_s)$. If the casing is gun-perforated, there will be a convergence loss due to the crowding of the flow lines into the perforations, and in addition, a second convergence loss because of the slotted liner or wire-wrapped screen, so that the pressure differential would be $(P_f - P_1)$, curve B. Curve C, in addition, takes into account the loss due to bridging of the sand grains on the liner, plus the head loss due to orifice action through the perforations and liner.

It has been pointed out[2] that the pressure differentials given by the radial flow equation would not exist in the immediate vicinity of the well bore if the sand were unconsolidated, or, if a liner, wire-wrapped screen pipe, or perforated casing were present. Considering the case where the casing is perforated and wire-wrapped screen pipe is set opposite the perforations, there would exist, instead of two-dimensional fluid motion symmetrical about an axis, a condition for a radial flow, an upward component tending to bring the fluid into the perforations, creating a problem in accordance with the three-dimensional flow equation.[3] This type of flow results in a converging of the flow stream into the perforations, causing a greater pressure loss. It has been shown[4] that the pressure loss resulting from the crowding or convergence of the streamlines in the sand decreases as the slot length increases, and that the pressure drop per unit rate of flow for a slot length one-half the sand thickness is three times the loss for a slot equal to the same thickness. Based on the same experimental work, and so placed that its center is midway between the upper and lower horizons defining the sand, the pressure drop across a ½-in. perforation would be approximately nine times that for a slot equal to the sand thickness. These results are predicated on an unconsolidated oil sand. If the sand is well consolidated and has a low vertical permeability, there will be a much greater convergence loss.

**TABLE 1**

**Slotted screen pipe***

| Size of pipe, in. | No. rows slots around pipe | Distance between slots around pipe, in. | Length of slot, in. | No. slots per ft. | Total lineal in. opening, per ft. | Sq. in. opening per ft. 0.010 ga. slots | Equiv. no. ½-in. perforations per ft. | Sq. in. opening per ft. of 0.020 ga. slots | Equiv. no. ½-in. perforations per ft. |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 3 | 2.04 | 1.625 | 48 | 78 | 0.78 | 3.9 | 1.56 | 7.9 |
| 4 | 4 | 1.909 | 1.625 | 64 | 104 | 1.04 | 5.3 | 2.08 | 10.6 |
| 4½ | 4 | 2.30 | 1.625 | 64 | 104 | 1.04 | 5.3 | 2.08 | 10.6 |
| 5 | 4 | 2.30 | 1.625 | 64 | 104 | 1.04 | 5.3 | 2.08 | 10.6 |
| 5½ | 5 | 1.83 | 1.625 | 80 | 130 | 1.30 | 6.6 | 2.60 | 13.2 |
| 6 | 6 | 1.84 | 1.625 | 96 | 156 | 1.56 | 7.9 | 3.12 | 15.9 |
| 6⅝ | 6 | 1.84 | 1.625 | 96 | 156 | 1.56 | 7.9 | 3.12 | 15.9 |
| 7 | 6 | 1.84 | 1.625 | 96 | 156 | 1.56 | 7.9 | 3.12 | 15.9 |

*Specifications taken from the catalog of Emsco Screen Pipe Company.

**TABLE 2**

**Plain drilled wire-wrapped screen***

| Size of pipe, in. | Size of round holes, in. | No. holes per ft. | Sq. in. area, per ft. | Lineal in. screen opening over each hole | Total lineal in. screen opening per ft. of holes | Sq. in. screen opening per ft. 0.008 ga. screen | Holes per ft. equiv. area | Sq. in. screen opening per ft. 0.010 ga. screen | Equiv. no. ½-in. perforations per ft. |
|---|---|---|---|---|---|---|---|---|---|
| 3 | ⅜ | 65 | 7.18 | 1 | 65 | 0.520 | 2.6 | 0.65 | 3.3 |
| 4 | ⅜ | 80 | 8.84 | 1 | 80 | 0.640 | 3.2 | 0.80 | 4.0 |
| 4½ | ⅜ | 96 | 10.61 | 1 | 96 | 0.768 | 3.9 | 0.96 | 4.9 |
| 5 | ⅜ | 96 | 10.61 | 1 | 96 | 0.768 | 3.9 | 0.96 | 4.9 |
| 5½ | ⅜ | 108 | 11.93 | 1 | 108 | 0.864 | 4.4 | 1.08 | 5.5 |
| 6 | ⅜ | 144 | 15.91 | 1 | 144 | 1.15 | 5.9 | 1.44 | 7.3 |
| 6⅝ | ⅜ | 144 | 15.91 | 1 | 144 | 1.15 | 5.9 | 1.44 | 7.3 |
| 7 | ⅜ | 156 | 17.24 | 1 | 156 | 1.24 | 6.3 | 1.56 | 7.9 |

*Specifications taken from the catalog of Emsco Screen Pipe Company.

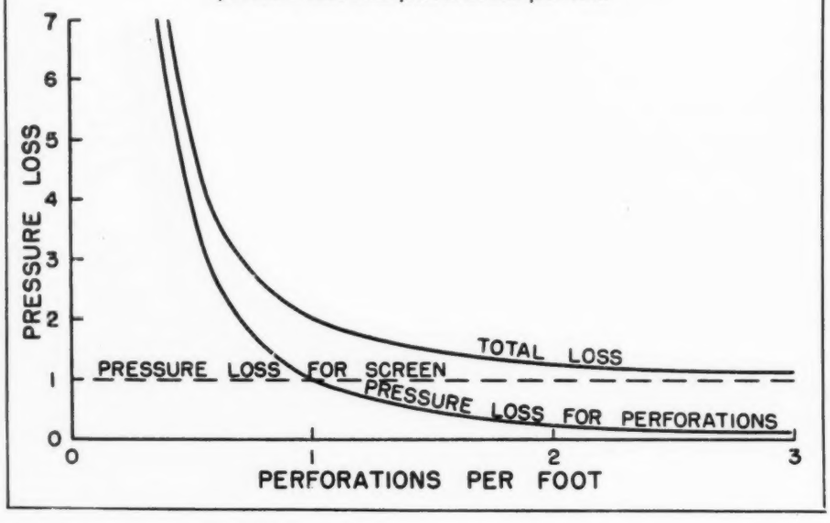
## Experimental Results

Experiments[5] showed the pressure loss resulting from the sand bridge over rectangular slots to be small, if the slot width used is equal to twice the grain size at the 10 percentile, but to increase as the slot width is reduced. Likewise, it is believed that the effect of bridging or filling of the perforations with sand would be small.

Although the pressure loss, due to openings in the slots[6], has been found to be small compared with the convergence loss, it would be approximately twice as large as when the liner is set in open hole, due to the orifice effect of the perforations, as illustrated in Fig. 2. If the total equivalent area of the perforations is twice that of the openings in the liner, this loss is one-fourth the liner loss; conversely, if this area is one-half, the pressure loss will be increased four times.

It is impossible to estimate how many of the gun-perforations remain open. It is standard practice with some operators to run a rock bit or mill past

*Fig. 2. Schematic diagram showing the relationship between pressure loss and perforations per foot*




[2]"Pressure Distribution about a Slotted Liner in a Producing Oil Well," by F. G. Miller, A.I.M.E. Tech. Pub. 1222, *Petr. Tech.*, Aug., 1940.

[3]M. Muskat: Loc. Cit., 260-261.

[4]F. G. Miller: Loc. Cit., 150.

[5]Idem, 150.

[6]Idem, 150.

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**TABLE 3**

**Vertical slotted wire-wrapped screen, standard slotting***

| Size of pipe, in. | Size of slots, in. | No. slots per ft. | Sq. in. area per ft. | Lineal in. screen opening over each slot | Total lineal in. screen opening per ft. | Sq. in. screen opening per ft. 0.008 ga. screen | Equiv. no. ¼-in. perforations per ft. | Sq. in. screen opening per ft. 0.010 ga. screen | Equiv. no. ½-in. perforations per ft. |
|---|---|---|---|---|---|---|---|---|---|
| 3 | ¼x3 | 18 | 13.5 | 6.75 | 121.5 | 0.97 | 4.9 | 1.21 | 6.1 |
| 4 | ¼x3 | 24 | 18.0 | 6.75 | 162.0 | 1.29 | 6.6 | 1.62 | 8.2 |
| 4½ | ¼x3 | 24 | 18.0 | 6.75 | 162.0 | 1.29 | 6.6 | 1.62 | 8.2 |
| 5 | ¼x3 | 24 | 18.0 | 6.75 | 162.0 | 1.29 | 6.6 | 1.62 | 8.2 |
| 5½ | ¼x3 | 30 | 22.5 | 6.75 | 202.5 | 1.62 | 8.2 | 2.02 | 10.3 |
| 6 | ¼x3 | 36 | 27.0 | 6.75 | 243.0 | 1.94 | 9.9 | 2.43 | 12.4 |
| 6⅝ | ¼x3 | 36 | 27.0 | 6.75 | 243.0 | 1.94 | 9.9 | 2.43 | 12.4 |
| 7 | ¼x3 | 36 | 27.0 | 6.75 | 243.0 | 1.94 | 9.9 | 2.43 | 12.4 |

*Specifications taken from the catalog of Emsco Screen Pipe Company.

**TABLE 4**

**Vertical slotted wire-wrapped screen, double slotting***

| Size of pipe, in. | Size of slots, in. | No. slots per ft. | Sq. in. area per ft. | Lineal in. screen opening over each slot | Total lineal in. screen opening per ft. | Sq. in. screen opening per ft. 0.008 ga. screen | Equiv. no. ¼-in. perforations per ft. | Sq. in. screen opening per ft. 0.010 ga. screen | Equiv. no. ½-in. perforations per ft. |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 1¼x3 | 30 | 22.5 | 6.75 | 202.5 | 1.62 | 8.3 | 2.02 | 10.3 |
| 4 | 1¼x3 | 42 | 31.5 | 6.75 | 283.5 | 2.26 | 11.6 | 2.83 | 14.4 |
| 4½ | 1¼x3 | 48 | 36.0 | 6.75 | 324.0 | 2.59 | 13.2 | 3.24 | 16.5 |
| 5 | 1¼x3 | 48 | 36.0 | 6.75 | 324.0 | 2.59 | 13.2 | 3.24 | 16.5 |
| 5½ | 1¼x3 | 54 | 40.5 | 6.75 | 364.5 | 2.81 | 14.3 | 3.64 | 18.5 |
| 6 | 1¼x3 | 60 | 45.0 | 6.75 | 405.0 | 3.24 | 16.5 | 4.05 | 20.3 |
| 6⅝ | 1¼x3 | 60 | 45.0 | 6.75 | 405.0 | 3.24 | 16.5 | 4.05 | 20.3 |
| 7 | 1¼x3 | 60 | 45.0 | 6.75 | 405.0 | 3.24 | 16.5 | 4.05 | 20.3 |

*Specifications taken from the catalog of Emsco Screen Pipe Company.

the perforations before going in the hole with the well setting to prevent bullets that may have wedged in the side of the casing from tearing the screen and to remove the mud filter cake over the perforations. Other perforations may be plugged with small pieces of cement and shale. Evidence of plugging has been obtained from an examination of screens removed from high gas-oil ratio wells. The screen pipe either showed the effect of, or was cut through entirely by, the jetting action of sand particles flowing through the limited number of open perforations.

## Summary

Due to the high pressure losses resulting from convergence or crowding of the fluid at the perforations, the pressure loss due to the orifice effect of the perforations, the cost of reworking wells when the screen pipe has become gas cut, and, finally, due to the plugging of a number of the perforations, it seems safe to conclude that the combined area of the gun-perforations per foot of casing should be within the range of one and one-half to twice that of the opening per foot of screen pipe.

☆ ☆ ☆

P 791.

# Corrosion Control in Refinery Pressure Vessels

Shown here is a fractionating tower that is maintained by arc welding and described in a paper that won the author, W. W. McClow, assistant general maintenance foreman, The Pure Oil Company, Toledo Refinery, Toledo, Ohio, an award of $3700 in the 2½-year $200,000 welding study program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

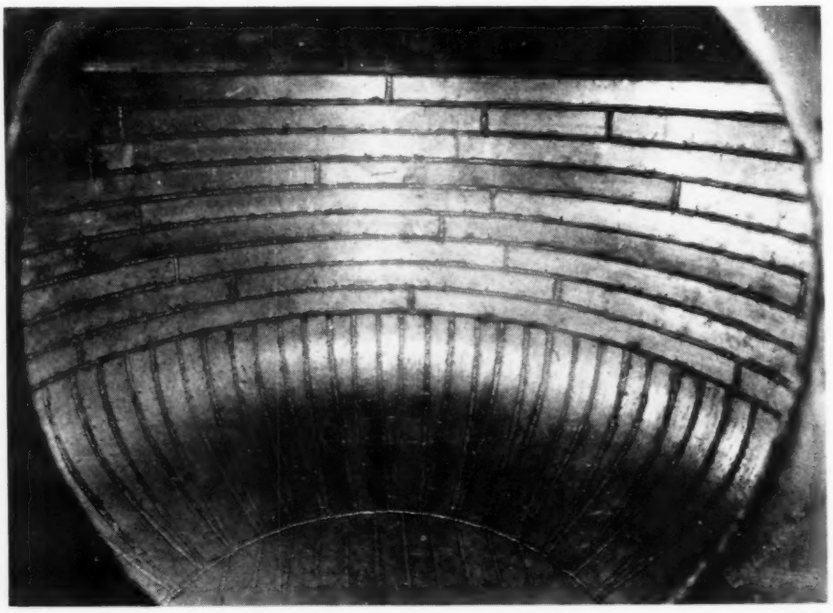
The author shows the economic advantages of extending the life of fractionating towers in gasoline refining by arc welding into the shells No. 12 BWG 12-14 percent chromium steel of 0.08 percent carbon. Steel strips are 4 in. wide, pickled and purchased on reels.

Average cost per sq. ft. per year of stainless steel liner is $0.33 as compared with carbon steel lining at $2.48 or a graphite lining at $2.16.

McClow is a graduate of the University of Michigan and is an associate member of the Scientific Research Society.

The Lincoln Foundation $200,000 Progress Award Program showed a possible annual cost saving of $1,825,000,000 including 7,000,000 tons of steel valued at $271,000,000 and 153,000,000 man hours of labor by utilization of arc welding.

Altogether, 408 awards were made to 458 recipients, the difference covering joint authorship. Awards embraced 46 divisions of participation, which encompassed the entire industrial field.



*Fractionating tower maintained by arc welding*

The great mass of important new welding data contained in the papers will be made available as soon as possible for the benefit of war industries—in the form of articles in trade publications and other magazines and eventually in book form.

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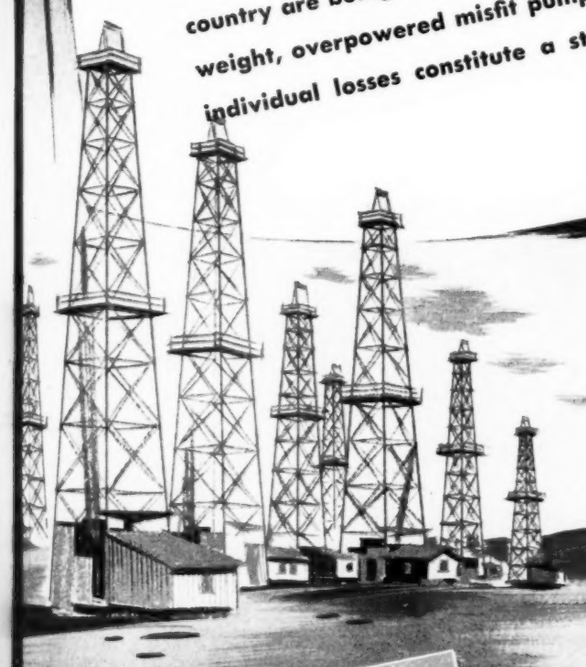

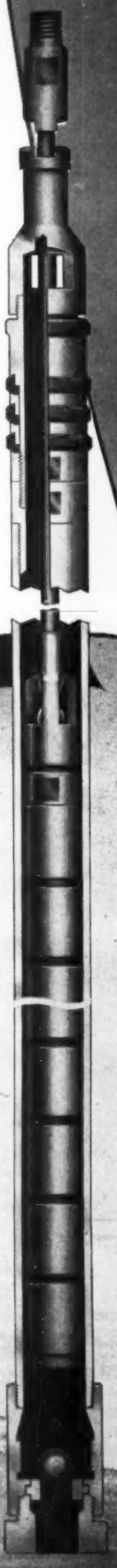

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P 772.2
P 537.5

*General view of the Griffin pressure-maintenance plant*

PETROLEUM ENGINEER Exclusive Feature

# Warren's Gasoline Plant-Pressure Maintenance Project

☆ **Extraction plant at Crossville, Illinois, utilizes 3-stage compression to final pressure of 600-lb. gauge—Pressure-maintenance unit situated at Griffin, Indiana**

*by L. A. Boyd*

Chief Engineer, Warren Petroleum Corporation

WARREN PETROLEUM CORPORATION'S newest natural gasoline plant, recently placed in operation at Crossville, Illinois, incorporates a number of unusual features. This plant, in addition to processing gas from about 500 wells in the Calvin-New Harmony area of Illinois, supplies absorption oil circulation to a remote absorber at the Griffin, Indiana, pressure-maintenance plant. The plant also receives and processes compression condensate from the Griffin pressure-maintenance plant.

The Illinois plant is situated on an escarpment overlooking the Wabash River Valley. This escarpment rises to an elevation of approximately 100 ft. above the floor of the valley. The plant is approximately midway between the north and south ends of the field. Due to its location on the escarpment, the plant is on the extreme western border of the productive area. High elevation of the plant necessitated the construction of an additional one-half mile of 24-in. O. D. gathering line.

An 8-ft. by 16-ft. vertical scrubber has been installed at the base of the escarpment, equipped with a conventional gravity drip for draining. It is of interest to note that, should this scrubber fill with 40-A.P.I. crude oil, 30-lb. pressure plus 10 in. of vacuum would be required to deliver oil to the top of the escarpment.

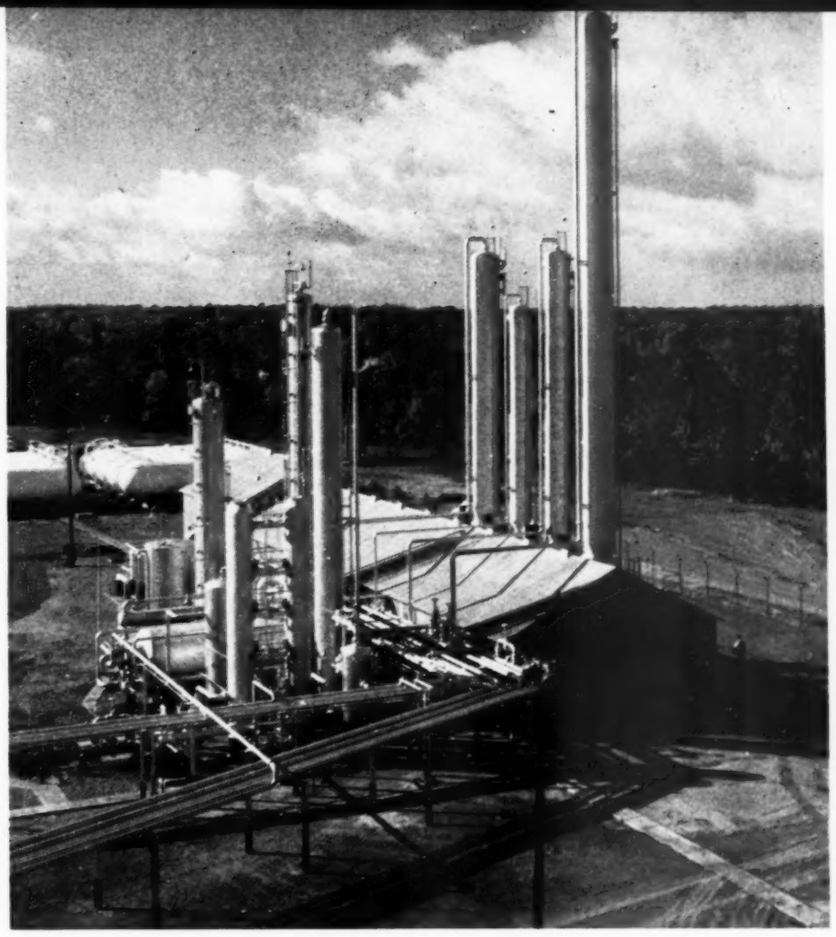
## Compressor Installation

Compressor installation consists of twelve 300-hp., 8-cylinder, V-type 3-stage compressors installed six in line back-to-back. In addition, one 4-cylinder, 400-hp., 2-cycle, 3-stage angle-type compressor has been installed. The total installed horsepower is 4000. All compressors are equipped with adjustable clearance apparatus to facilitate proper loading of the engines for various discharge pressures. This feature was deemed desirable because it is possible that at some future date the present 600-lb. discharge pressure will not be necessary.

As a safety measure, manually-operated shut-down apparatus has been installed at points remote from the compressor room. In addition, all engines are equipped with automatic shut-down apparatus, should oil or water temperatures become too high. Engine and compressor cooling is done in an enclosed cooling system. Direct-connected, centrifugal water-circulating pumps are installed on the twelve 300-hp. compressors. The 400-hp. compressor has a separate centrifugal pump driven by a

**L. A. BOYD**

first became affiliated with the petroleum industry in 1919 when he joined the staff of Trans-Continental Oil Company as laboratory and test man—Transferred to Big Lake Oil Company in 1925 as plant chemist—In 1926 he entered the employ of Signal Oil and Gas Company as chemist and was later superintendent and district superintendent—Joined staff of Gas and Oil Products, Ltd., Calgary, Alberta, Canada, in 1934 as general superintendent of refineries—Accepted position as chief engineer with Warren Petroleum Corporation in 1940.



*Gasoline plant at Crossville, Illinois, to which is connected 500 wells*

V-belt from a dishpan pulley attached to the flywheel. Separate pumps have been installed to supply cool water to lubricating oil coolers. This feature was decided as being necessary in order to provide a more definite control of the lubricating oil temperatures.

Gas enters the plant through a 24-in. O. D. line under 10 inches of Hg vacuum. After passing through a 10-ft. diameter, vertically mounted, intake scrubber, the stream is split and enters two 20-in. O. D. headers. These headers run the length of the compressor building on each side. Individual compressor suctions are connected directly to this header. Discharge gases from each stage is passed first through a specially designed scrubber placed in the discharge line between the compressors and gas coolers.

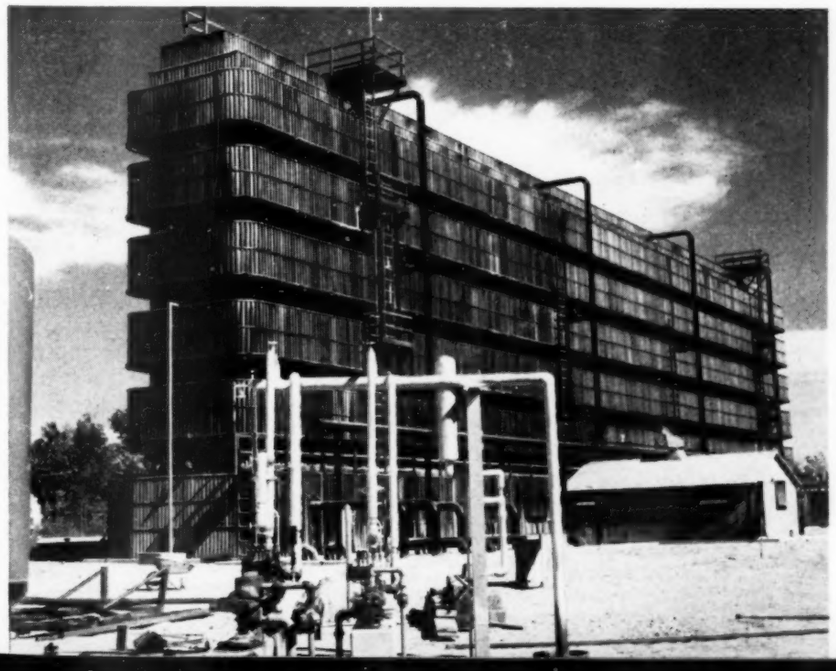
The first- and second-stage gases, after passing the coolers, enter accumulators for condensate removal. These accumulators also act as scrubbers for the succeeding stage. Automatic safety apparatus will shut-down the accumulators in event the liquid reaches too high a level. Provisions have been made to introduce the condensate from these accumulators, either into the fat oil stream or into the third-stage discharge upstream from the third-stage coolers.

The third-stage gases, after passing the coolers, enter an accumulator where the condensate is removed. The gas from this accumulator passes directly into a 4-ft. by 54-ft. absorber under a pressure of 600-lb. gauge. After passing the absorber, the gas enters a florite dehydration unit where the dew point is depressed to zero minus. This dehydration unit consists of two 3-ft. by 30-ft. adsorbers designed for an operating cycle of 12 hours. Regeneration, or drying, of the adsorbers is accomplished by passing a stream of heated gases through the tower. The heated gases, upon leaving the tower, pass through a cooler where excess moisture is precipitated and removed in an accumulator. The cooled gases, leaving the accumulator, re-enter the main gas stream.

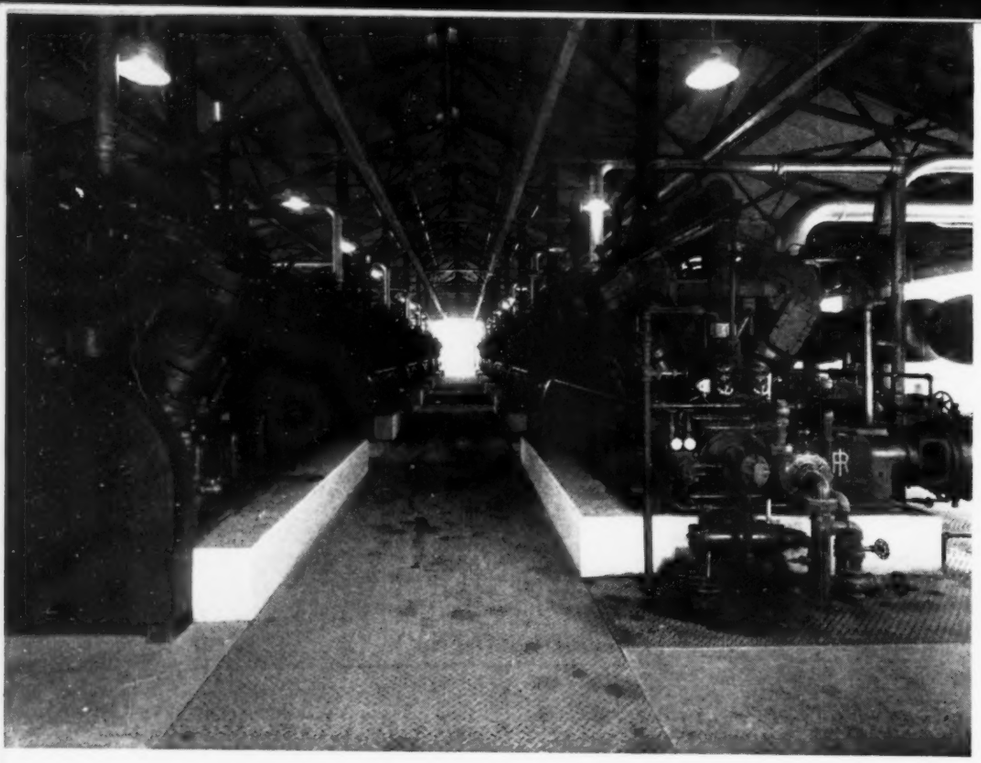
Oil is introduced into the absorber through a rate-of-flow controller by either of two direct-connected, electric-driven, reciprocating pumps. The lean oil charging pump, operating at a pressure of 850 lb., also supplies oil circulation to the remote absorber at the Griffin, Indiana, pressure-maintenance plant. The oil flow to this absorber is also controlled by a rate-of-flow controller. Pressure on the lean oil charging pump is maintained constant by an instrument-controlled back-pressure valve discharging into the lean oil surge tank.

Fat or saturated oil from the absorber, together with oil from the remote absorber, is introduced into the fat oil stabilizer where partial fractionation is obtained. Oil from the base of the fat oil stabilizer enters a specially designed heat exchanger, consisting of a 10-ft. by 20-ft. tank containing three multi-tubular heat exchanger bundles and one steam heater bundle. Webs divide the tank horizontally and vertically to obtain the usual countercurrent flow necessary to good heat transfer. The steam heater bundle, in the heat exchanger tank, is used to control the fat oil stabilizer base temperature. Reflux for the fat oil stabilizer is cool lean oil from the lean oil surge tank supplied by a steam-driven, reciprocating pump through a rate-of-flow controller. Waste gases from this tower, consisting of methane, ethane, and some propane, pass to a low-pressure header where they are available at 50-lb. pressure for boiler or other fuel purposes.

The stabilized fat oil is pumped from the heat exchanger by either of two direct-connected, electric-driven centrifugal pumps through a steam-heated preheater into a combination still. This still consists of both stripping and de-



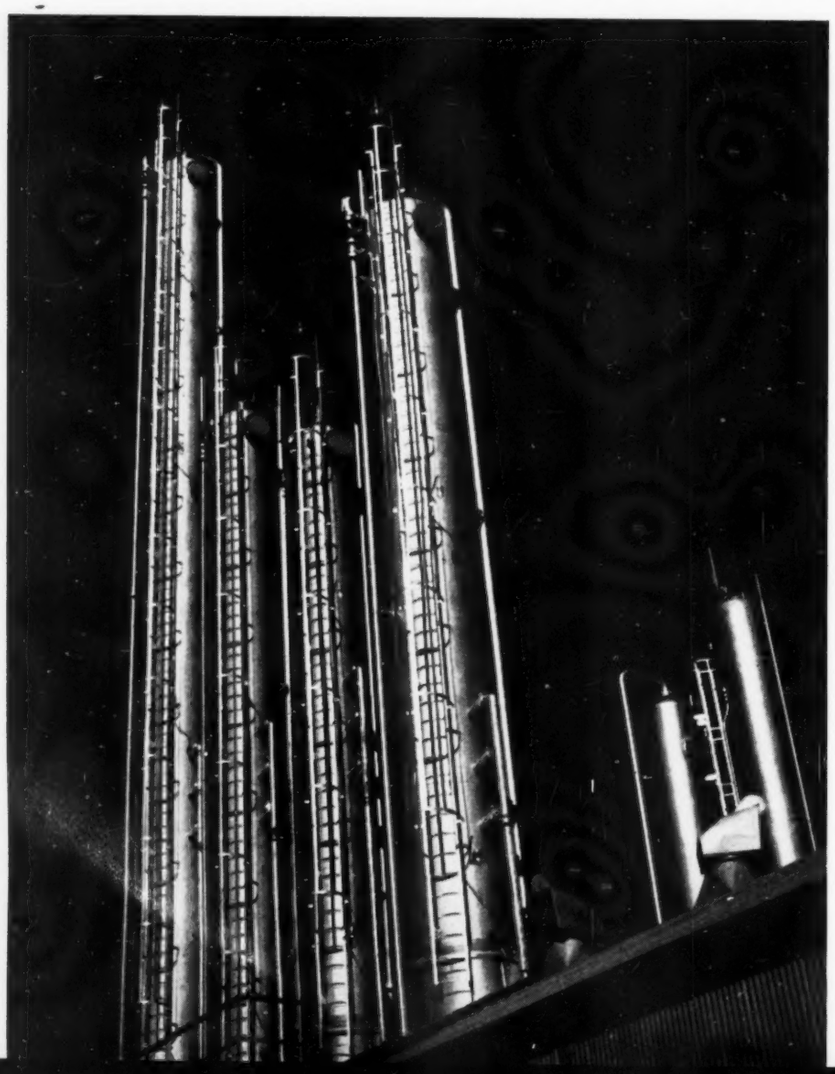
*This 32-bay, natural draft, redwood cooling tower has been erected at the Crossville plant*



*The compressor installation at Crossville consists of twelve 300-hp., 8-cylinder, V-type, 3-stage compressors, and one 4-cylinder, 400-hp., 2-cycle, 3-stage, angle-type compressor*

phlegmating sections, with automatically controlled external dehydrating apparatus. The top temperature is maintained constant by an instrument-controlled, simplex, close-clearance, reciprocating pump, which takes suction from the raw gasoline receiver tank. The overhead end-point-controlled product passes through open section coolers to the run-down tank, from where it is pumped as feed to the primary stabilizer. It should be mentioned here that, due to the compression pressure of 600 lb., there is only a small fraction of the *iso*pentane and heavier remaining in the gas after compression. As a result, the absorption and distillation systems operate primarily on butanes and lighter fractions.

From the third-stage accumulator, the compression product, together with the compression product from the Indiana pressure-maintenance plant, goes under its own pressure to a flash tank. This flash tank, operating under automatically controlled temperature and pressure, flashes off a large volume of the more volatile fractions. Vapors from the flash tank enter the fat oil stabilizer, where further separation between the desirable and undesirable volatile hydrocarbons is obtained. Some of the liquid product from the flash tank is introduced into the distillation unit as reflux. The excess over reflux requirements is introduced directly into the primary stabilizer.



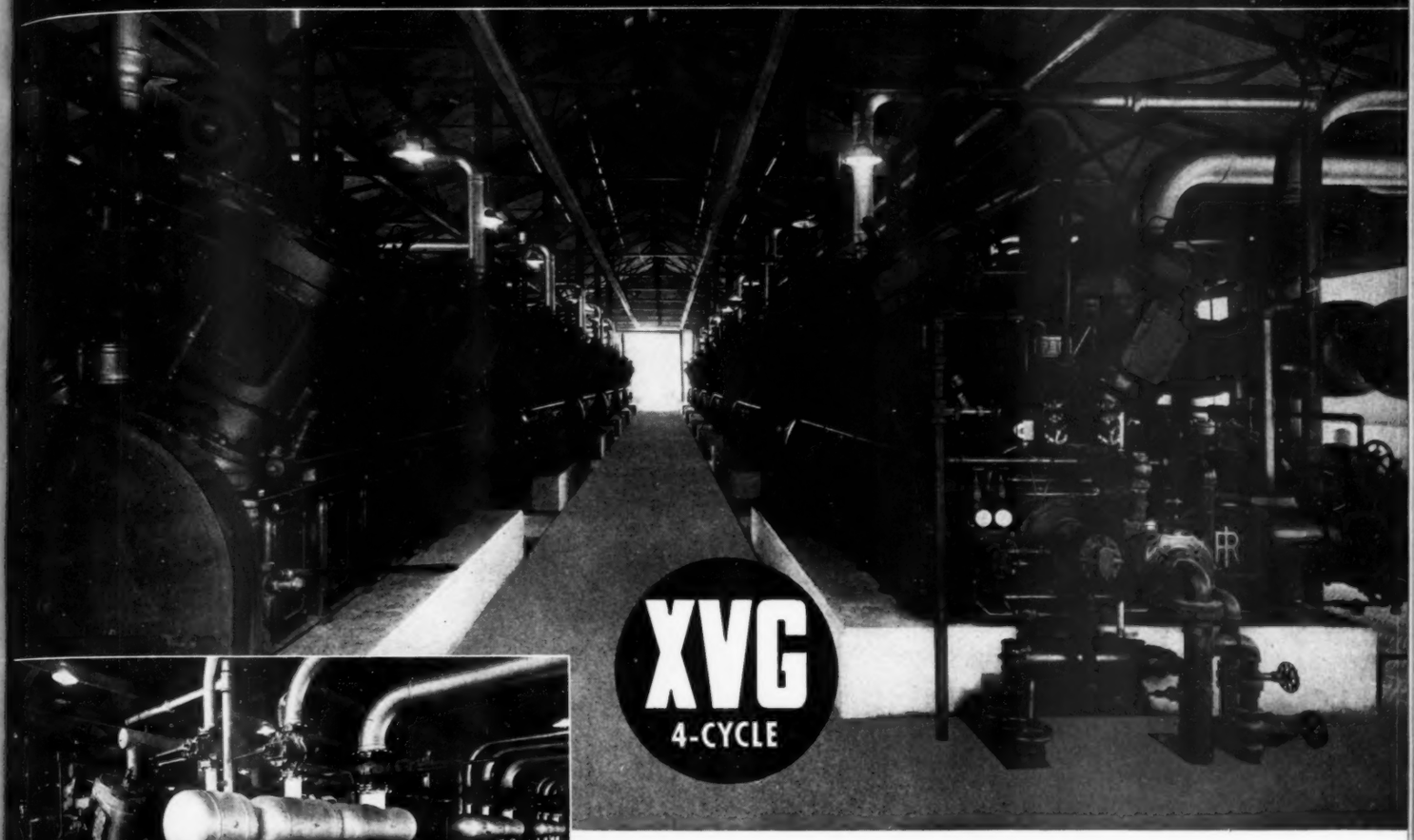
*From left to right the towers in the foreground are the debutanizer, depropanizer, deethanizer, and stabilizer*

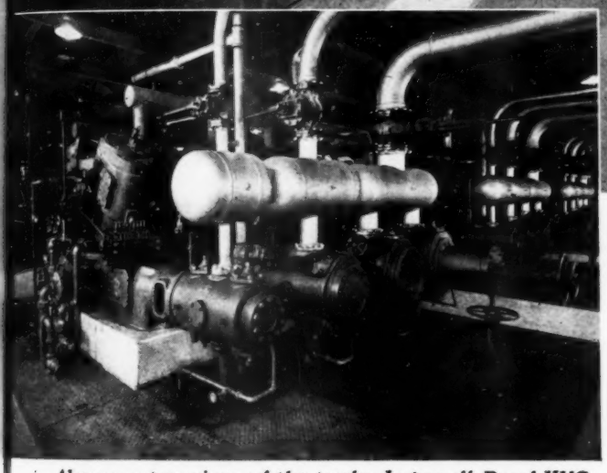
## Stabilization

The raw product from the flash tank and the run-down tank is introduced into the first stabilizer by steam-driven, close-clearance pumps. The vapor-pressure-controlled natural gasoline is taken from the base of this tower through automatic liquid-level controls. Stabilized natural gasoline passes from this tower under its own pressure through an alkaline wash, to remove any $H_2S$ that may remain after stabilization. After the alkaline wash, the stream passes through a 5-ft. by 20-ft. settling tank and sand filter to remove any entrained alkaline solution. From the sand filter, the stream continues through either of two 5-ft. 6-in. by 12-ft. solid cupric chloride treaters to storage. Overhead product from this tower is pumped from the reflux accumulator by an automatically controlled, steam-driven, close-clearance pump into the No. 2 stabilizer. Due to the rejection of a large percentage of the methane and ethane by the fat oil stabilizer, the overhead from this tower runs total condensing.

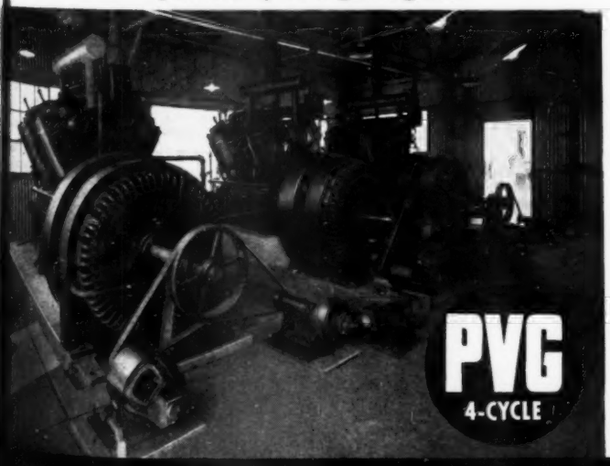
The second stabilizer rejects any remaining ethane and dissolved methane, along with some propane. These products pass off the reflux accumulator as waste and are introduced into the 50-lb. header where they are available for fuel. Base products from this tower, consisting of propane, *iso*butane, and normal butane, pass under tower pressure through an alkaline wash to remove the $H_2S$. After the alkaline wash, the product continues to a 5-ft. by 20-ft. surge tank, which settles out any entrained alkaline solution. These LPG (liquefied

# 15 GAS-POWERED UNITS



*Above are two views of the twelve Ingersoll-Rand XVG compressors. Below is a view of the three generator sets powered by PVG gas engines.*




## Ingersoll-Rand Compressors and Engines at new Illinois Plant Operated by Warren Petroleum Corporation

The combination natural gasoline and repressuring station operated by the Warren Petroleum Corporation in Illinois is a new and important link in our country's war program to expand the production of high octane gasoline.

Twelve 300-hp Ingersoll-Rand Type XVG 3-stage gas-engine-driven compressors will receive gas at 10″ Hg. vacuum, and deliver it at pressures up to 400 lb per sq in. for injection back into the sand. Electric power for the plant is furnished by three generator sets, each powered by a 185-hp Ingersoll-Rand Type PVG gas engine having interchangeable parts with the XVG's.

Ingersoll-Rand 4-cycle oil-field units are built in standardized sizes from 75 to 800 hp. In addition to the famous gas-engine-driven compressor line, power units are widely used for driving generators, geared or direct-connected pumps, and reciprocating pumps.

*Other I-R products for oil-field and refinery work include all kinds of Compressors and Pumps, Diesels, Steam-Jets, Pneumatic Tools, and Rock Drills. There is an I-R branch office in every producing center.*

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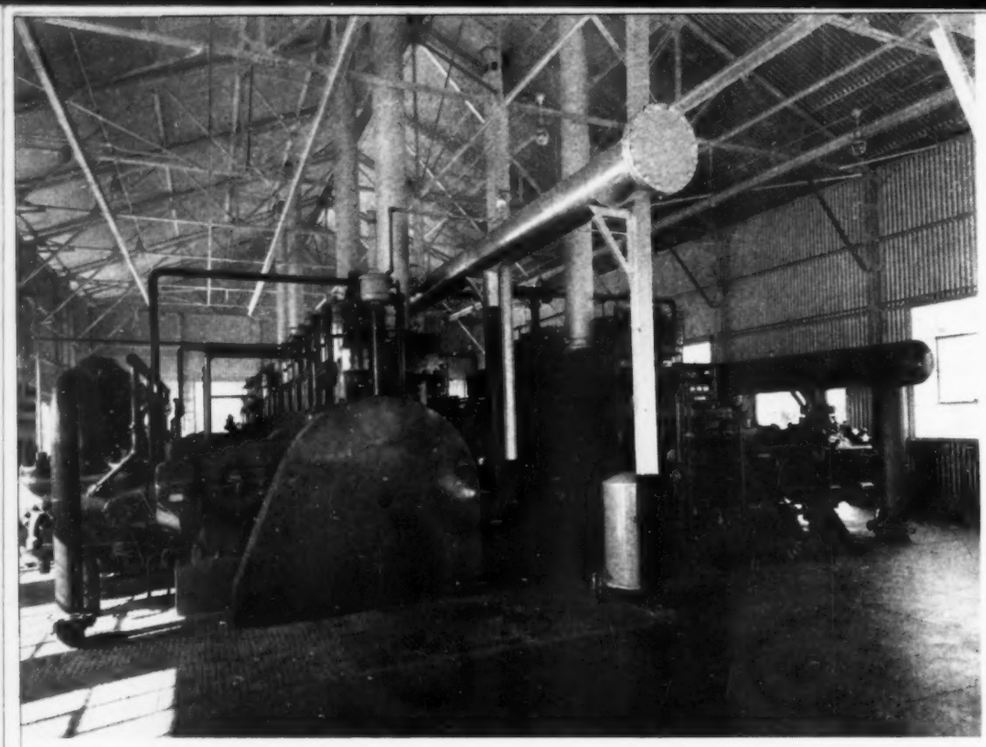


*Four 600-hp., 3-stage, 2-cycle, angle-type compressors have been installed at the Griffin pressure-maintenance plant*

petroleum gas) products are pumped by steam-driven, close-clearance, reciprocating pumps to the third stabilizer, where propane is removed as an overhead product. The propane from the reflux accumulator is taken from reflux pump discharge through an automatic liquid-level control. This product, under reflux pump pressure, passes through a florite dehydration unit to storage.

The base product under tower pressure passes through an automatic liquid-level control to the fourth stabilizer, where *iso*butane is removed as an overhead product from the reflux accumulator by an automatic liquid-level control on reflux pump discharge. Normal butane is removed from the base of this tower by an automatic liquid-level control. Both *iso*butane and normal butane pass directly to storage without further refining.

## Steam Plant

Steam for plant operation is generated by seven 125-hp. locomotive-type, oil-field boilers, which are installed in line in a 96-ft. by 25-ft. 6-in. steel building. All boilers are insulated and provided with automatic water-level and steam-pressure controls. Boiler-feed water is supplied by either of two 10 by 5½ by 10 duplex steam-driven, piston-packed pumps. Boiler-feed pumps are equipped with pump governors to maintain a constant pressure on the feed water. Feed pumps take suction from an elevated hot well of atmospheric type. All water condensate from the plant, with the exception of dephlegmator water, returns to the hot well. Dephlegmator water is rejected because it is contaminated by sulphur from the absorption oil.

## Electric Power Plant

The electric power installation consists of three 156-kva., 3-phase, 60-cycle, 440-volt generators, direct-connected to 4-cylinder, V-type, 4-cycle gas engines of 185 hp.

## Cooling System

Plant cooling is accomplished in a 32-bay, natural draft, redwood cooling tower. Water is circulated over the tower in the conventional manner by either of two 5000-gal. per min. centrifugal pumps, direct-connected to 125-hp. electric motors. Circulating pumps are installed in a pit to provide for flooding the suction. Open-type cooling sections have been used throughout and they are of both horizontal and vertical construction.

## Storage

Working storage has been provided for all products. Natural gasoline is stored in eight 1000-bbl. tanks and one 20,000-bbl. spheroid. The 1000-bbl. tanks are 12 ft. in diameter and 54 ft. long overall with spherical heads. Six 10-ft. by 45-ft. 600-bbl. tanks, of similar construction, have been provided for the storage of normal butane. Four 7-ft. by 30-ft., 210-bbl. tanks of dished-head construction have been installed for the storage of *iso*butane. Five tanks of the same size have been installed for the storage of propane.

## Loading Facilities

A 24-car, all-steel loading rack has been erected on a private spur of the New York Central Railroad, approximately 2.1 miles from the plant. Due to seepage covering a large part of the area around the spur it was necessary to install a quite extensive drainage system before construction could be completed. Separate loading lines have been provided for all products. The three LPG products are loaded through separate 2-in. lines. A 6-in. line has been provided for loading natural gasoline.

## Water Supply

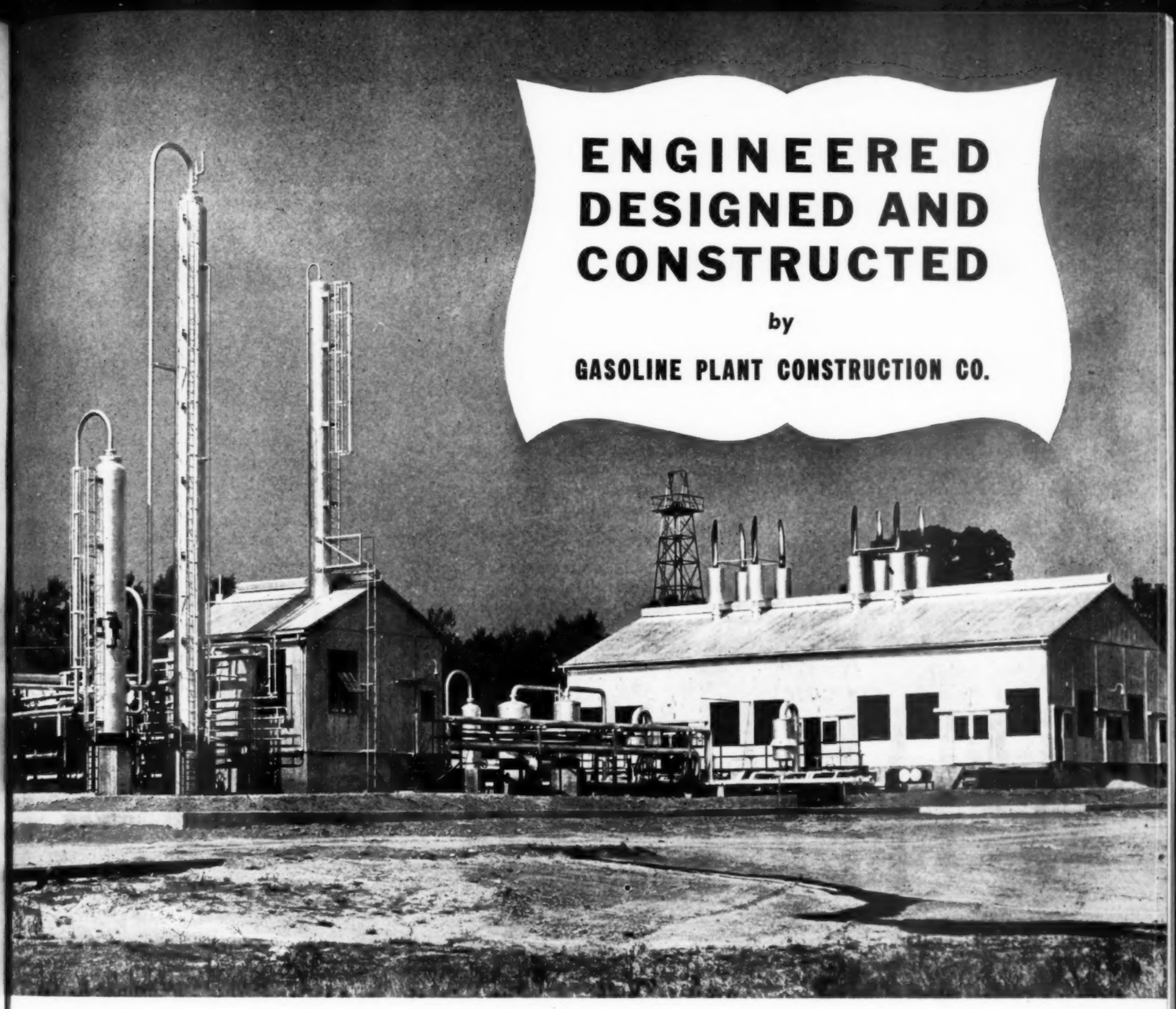
Water for plant operation is supplied by two 60-ft. wells, situated approximately one-half mile east of the plant. The wells have a capacity of 300 gal. per min. Either has ample capacity to supply all plant and domestic requirements. Due to the shortage of copper wire, the wells were installed for multi-cylinder gas engine drive. One pump is equipped with a V-belt drive and the other with a right-angle gear drive.

## Illinois Gathering System

The Illinois gathering system consists of approximately 100 miles of pipe, varying in size from 2 in. to 24 in. The entire system is in an area subject to frequent flooding by waters of the Wabash River. Due to this condition, it was necessary to anchor all pipe larger than 6 in. This necessitated the installation of approximately 3000 expanding anchors. The area in which this system was installed is crossed and recrossed numerous times by two meandering streams, known as the Fox and Little Fox rivers. In addition, it was necessary to cross the old channel of the Wabash River in order to reach the Ribeyre Island area of Indiana. It was also necessary to make numerous over-water and under-water crossings; due to the numerous adverse conditions encountered, the construction of this system proved to be slow and expensive. State laws prohibit obstruction to the flow of any stream. It was found necessary to bury under-water crossings below river beds and over-water crossings were elevated above the highest recorded flood stage level. This necessitated over-water crossings as high as 35 ft. above the normal water level.

Considerable difficulty was encountered in designing satisfactory drainage apparatus for vacuum lines on under-water crossings. The drainage situation was aggravated by the great depth of some of the crossings and the fact that many were submerged under several feet of water. In addition to the rivers mentioned, there were numerous swamps and small lakes that impeded construction progress.

Approximately 200 drips have been installed in this system to remove crude oil or condensate that might accumulate. All drips placed near elevated meter settings have been piped to permit draining from meter platform by means of extended valve handwheels. Drips at



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# *Warren Petroleum Corporation*

## *Griffin, Ind., Plant*

For Compressor Station for Repressuring System

with

Absorption and Dehydration of gas at 750 pounds pressure

**GASOLINE PLANT CONSTRUCTION COMPANY**

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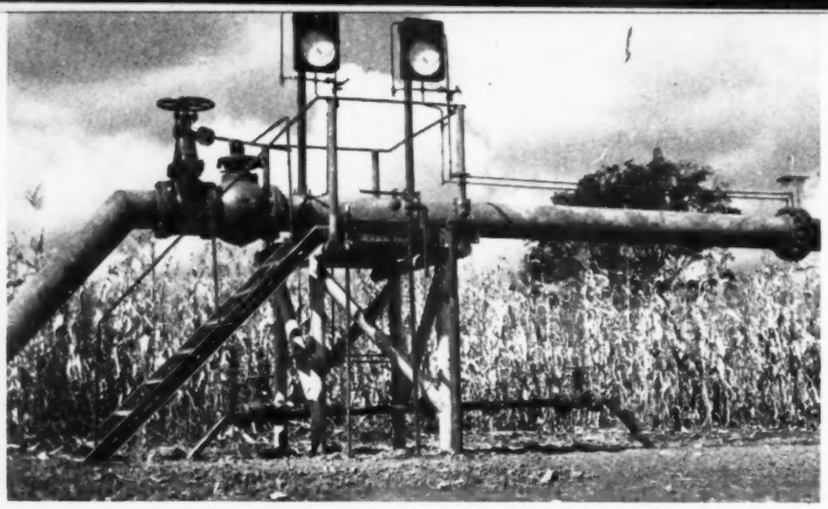
**HOUSTON, TEXAS**



*Meter setting elevated above flood level*

points remote from meter settings are provided with extended valve handwheels to permit draining during times of flood. Due to the pressure of 600 lb. on the residue system, it has been necessary to install relief valves between control valves and the drip to prevent excessive pressure on drips.

Gas is gathered in the conventional manner. Connections have been made to approximately 450 casingheads and about 125 low-pressure separators. In addition to the usual wet gas meters, it is necessary to meter residue gas to each lease. These meter installations meter the gas being returned to the producing formations and are in addition to those installed by the producer. All meters have been installed on elevated platforms above flood level. The gas is produced from four zones. The Aux Vases, Cypress, and Waltersburg are sand formations, and the McCloskey a lime formation. There is very little $H_2S$ present in gas produced from the three sand formations. Gas produced from the McCloskey lime, however, has an appreciable amount of this undesirable constituent. The $H_2S$ content, after the mixing of all gases from the four zones, has been reduced to approximately 10 grains per 100 cu. ft. It is not expected that this amount of $H_2S$ will cause serious operating difficulties.

A recent analysis of wet and residue gas is shown in Table 1.

TABLE 1

$H_2S$ 10 grains per 100 cu. ft.

| | *Wet gas* | | *Residue gas* | |
|---|---|---|---|---|
| | *Mol. percent* | *Gal. per min.* | *Mol. percent* | *Gal. per min.* |
| Methane | 63.71 | 10.79 | 81.87 | 13.87 |
| Ethane | 13.13 | 3.13 | 12.71 | 3.03 |
| Propane | 12.54 | 3.44 | 5.42 | 1.49 |
| *Iso*butane | 1.56 | 0.51 | | |
| Normal butane | 4.95 | 1.56 | | |
| *Iso*pentane | 1.44 | 0.53 | | |
| Normal pentane | 1.54 | 0.56 | | |
| Hexanes and heavier | 1.13 | 0.48 | | |

It is calculated that present extraction, in addition to recovering approximately all *iso*butane and heavier, recovers approximately 52 percent of the potential propane.

## Pressure-Maintenance System

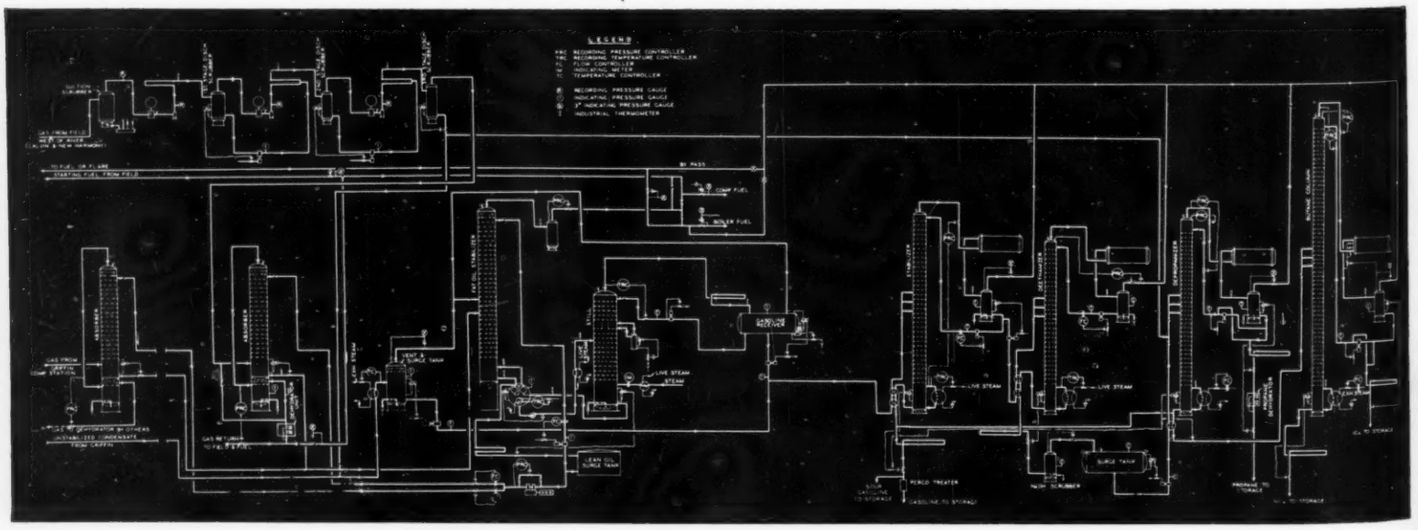
Residue gas, after dehydration, is returned to the field for pressure maintenance and lease operations. The main residue lines, consisting of approximately 12 miles of 3-in., 4-in. and 6-in. pipe, run parallel to the wet-gas trunk lines. Because the gas is dehydrated, drips were not deemed necessary in this system. Being of small size these lines offered no serious construction difficulties. Gas is returned and metered to each lease under 600-lb. pressure. From lease dry gas meters, gas is taken to wells designated for input by engineers of the producing companies. Due to the difference in pressure and porosity of various formations, it is necessary to introduce gas into each zone separately. Many are multiple input wells through which gas is injected into as many as three different zones. Meters have been installed for metering gas going to each zone.

Some difficulties have been encountered due to the formation of hydrates at points of injection. The pressure-maintenance system was operated for some time before the dehydration unit was placed in operation and during this period water was deposited from the saturated gas. When dehydrated gas was introduced into this system, moisture again saturated the gas causing hydrate formation. It is anticipated this condition will correct itself once the moisture previously accumulated is removed from the distribution system.

## The Indiana Plant

The Indiana plant is situated in the Wabash River Valley, northwest of the town of Griffin, Indiana, and was erected primarily to compress gas for pressure maintenance. As previously mentioned, an absorber has been installed at this plant, the circulation being supplied from the Illinois plant. Compres-

*Flow diagram of the extraction plant at Crossville*



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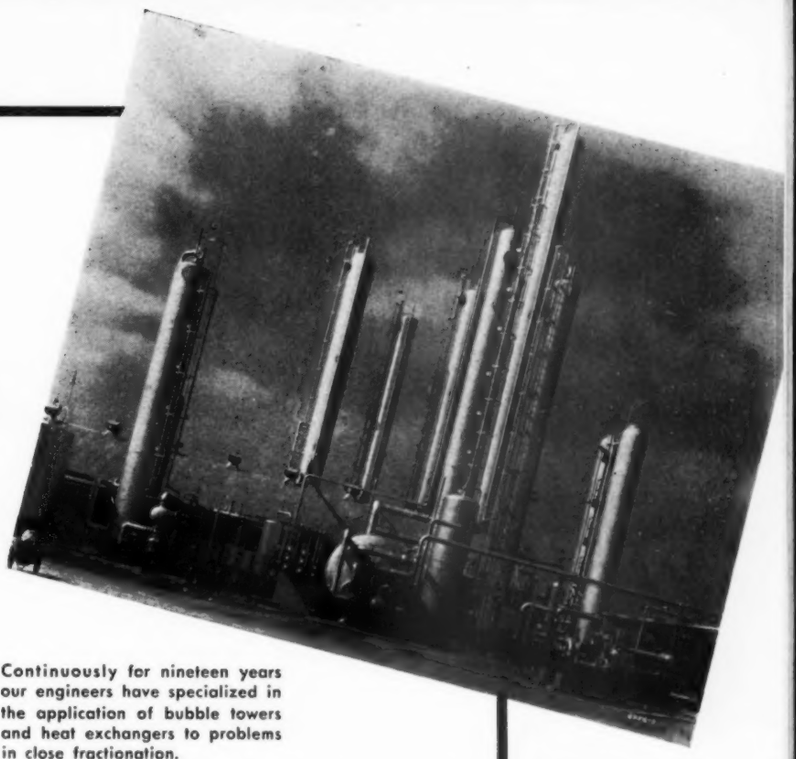
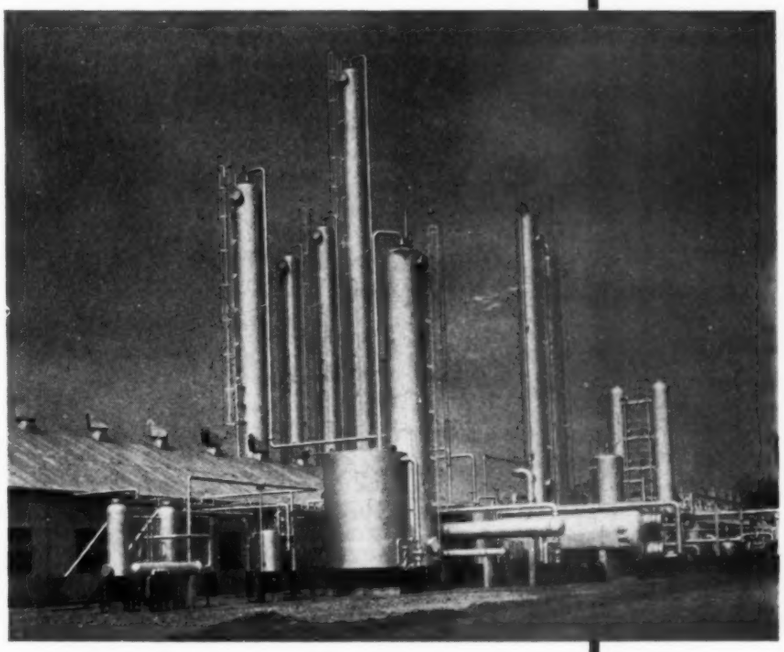


Continuously for nineteen years our engineers have specialized in the application of bubble towers and heat exchangers to problems in close fractionation.



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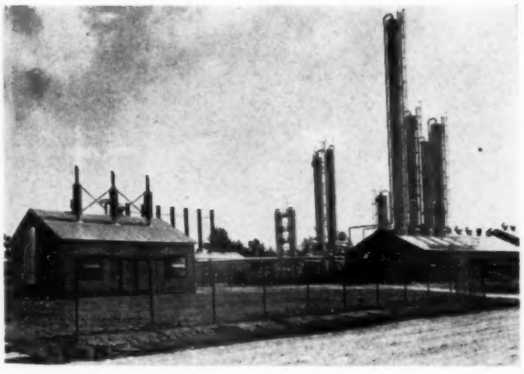

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## ENGINEERING & CONSTRUCTION DIVISION

## FRICK-REID *Supply Corporation*

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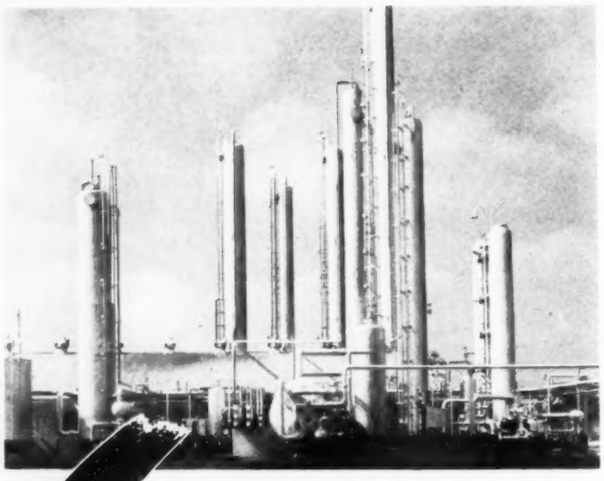
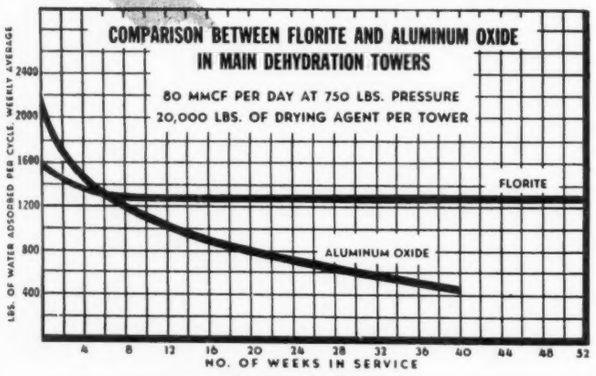


n Dehydration for
REPRESSURING
the approved Desiccant is

Florite*

The chart below represents the long-term efficiency of FLORITE* as a drying agent for natural gas. FLORITE* is now the approved desiccant in many such operations, especially those for repressuring. Is equally effective in the treatment of various other gases and liquids. Will selectively adsorb 4 to 20% its weight of water — is regenerated by heating to 350° F. Nationally known chemical manufacturers are among the regular users. Full information on request.

The long-sustained effectiveness of FLORITE in adsorbing relatively large amounts of water is shown. Note that the results were more and more favorable to FLORITE as weeks passed.


COMPARISON BETWEEN FLORITE AND ALUMINUM OXIDE
IN MAIN DEHYDRATION TOWERS
80 MMCF PER DAY AT 750 LBS. PRESSURE
20,000 LBS. OF DRYING AGENT PER TOWER
LBS. OF WATER ADSORBED PER CYCLE, WEEKLY AVERAGE
2400
2000
1600
1200
800
400
FLORITE
ALUMINUM OXIDE
4 8 12 16 20 24 28 32 36 40 44 48 52
NO. OF WEEKS IN SERVICE

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sion condensate is transported by pipe line to the Illinois plant for stabilization and treating. The compressor installation consists of four 600-hp., 3-stage, 2-cycle, angle-type compressors. Jacket water cooling is done in an enclosed system. Each compressor has an individual 500 gal. per min. centrifugal water-circulating pump, driven by V-belt from a dish-pan pulley attached to the flywheel of the engine. The lubricating oil is cooled by bypassing all or a part of it, returning cool water through a lubricating oil cooler situated alongside the engine.

Gas enters the plant through a 14-in. and a 20-in. line. Before entering the suction header, the gas passes through a 6-ft. by 20-ft. scrubber to remove possible crude oil or condensate from the stream. Leaving the scrubber, the gas stream divides into two 16-in. headers, to which individual compressor suctions are connected.

Discharge gas, from the first and second compression stages, passes through open-type coolers to accumulators where the compression product is removed. Provisions have been made to introduce automatically the product from these accumulators, either into the third stage discharge upstream of the coolers or into the fat oil stream.

Third stage gas, under 750-lb. pressure, after passing through the coolers, enters an accumlator. Here the condensate is removed by an automatic liquid-level control. This product is transported through a 2½-in. line approximately 6 miles to the Illinois plant for further processing. Gas from the accumulator goes directly to a 3-ft. by 50-ft. absorber, oil circulation for which is supplied from the Illinois plant as previously mentioned. Gas, after passing the absorber, enters a diethylene glycol contactor where the dew point is depressed to approximately zero. After dehydration the residue gas is returned to the field for pressure maintenance and lease operations.

As this plant was erected in an area subject to frequent flooding, it was deemed advisable to elevate all vital equipment above flood level. Equipment was elevated approximately 7 ft. above the original ground level. As large volumes of cool water are available from shallow wells situated in the plant yard, no cooling tower was erected. Water is pumped directly from wells to the coil shed by either of two electrically-driven turbine type pumps, each of which has a capacity of approximately 800 gal. per min. Water from the wells is used to cool the gas and diethylene glycol solution. Two direct-connected, electric-driven, 1900 gal. per min. pumps have been installed to re-circulate basin water for jacket cooling.

## Indiana Gathering System

The gathering system of the Indiana plant is very similar to the Illinois system previously described. There are approximately 40 miles of pipe varying in size from 2 to 20 in.

Approximately 110 drips were required, the method of installation being similar to that employed in the Illinois system. Approximately 90 meters are required to meter wet and dry gas in this area and are in addition to meter installations required for pressure-maintenance operations.

In addition to the gathering system, two 3-in. absorption oil-circulating lines and one 2½-in. condensate line connect the two plants.

## Acknowledgment

The writer wishes to express his appreciation for the liberal assistance given by L. M. Mauney, chief chemist; and to J. R. Strain, purchasing agent, for the photographs used.

## Contractors

The Engineering and Construction Division of the Frick-Reid Supply Corporation, Tulsa, Oklahoma, engineered, designed, and constructed the Illinois plant. The Gasoline Plant Construction Corporation, Houston, Texas, engineered, designed, and constructed the plant at Griffin, Indiana.

# THE *Petroleum* Engineer's CONTINUOUS TABLES

## A DAILY REFERENCE FOR OPERATING MEN

## INSTALLMENT NO. 65

THE Continuous Tables were adopted as a valuable and regular feature of *The Petroleum Engineer* six years ago. Throughout the last five years the original objective of the tables, to save time and effort for the technician and the practical field or plant worker, has been strictly adhered to. As a result, their reception has been such as to lead the editors to believe that they are accomplishing their original objective. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.*

A part of the original objective of the tables was the presentation of the data in the simplest form available—tabular form data are believed the most accurate and readily followed by the average reader than any other method available. There are many types of information best presented by curves or nomographs when three or more variables must be considered simultaneously. Such data as must be presented in the form of charts and graphs were begun with the 62nd installment.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

To readers of *The Petroleum Engineer,* who are only now becoming interested in the Continuous Tables, it should be pointed out that each table is assigned a filing or index number that conforms with the Dewey Decimal System of classification as modified and extended for the petroleum and related industries by L. C. Uren, professor of Petroleum Engineering at the University of California. This complete index has been published in earlier installments of the tables and is now available in booklet form at a cost of 50 cents per copy from *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas. Complete sets of the tables from the first installment to the present are also available in conjunction with subscriptions.

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| LeRoi Company | 158 | Oct. | P 514.541. |
| LeRoi Company | 142 | Nov. | P 516.922.005. |
| Ridge Tool Company | 162 | Oct. | P 546.32 |
| Twin Disc Clutch Company (sheet 2) | 136 | Nov. | P 670. |
| Universal Atlas Cement Corporation (sheet 3) | 130 | Sept. | P 532.911. |
| Vortox Manufacturing Company (sheet 18) | 72 | July | P 683.32 |
| Vortox Manufacturing Company | 164 | Oct. | P 683.32 |
| Waukesha Motor Company | 128 | Sept. | P 615.3 |
| Whitney Chain and Manufacturing Company | 132 | Sept. | P 621.11 |
| Whitney Chain and Manufacturing Company | 140 | Nov. | P 615.211. |

# TEMPERATURE CONVERSION—FAHRENHEIT AND CENTIGRADE

| Temp., °C. or °F. | °C. | °F. | Temp., °C. or °F. | °C. | °F. | Temp., °C. or °F. | °C. | °F. | Temp., °C. or °F. | °C. | °F. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1010 | 543 | 1850 | 1610 | 877 | 2930 | 2210 | 1210 | 4010 | 2610 | 1432 | 4730 |
| 1020 | 549 | 1868 | 1620 | 882 | 2948 | 2220 | 1216 | 4028 | 2620 | 1438 | 4748 |
| 1030 | 554 | 1886 | 1630 | 888 | 2966 | 2230 | 1221 | 4046 | 2630 | 1443 | 4766 |
| 1040 | 560 | 1904 | 1640 | 893 | 2984 | 2240 | 1227 | 4064 | 2640 | 1449 | 4784 |
| 1050 | 566 | 1922 | 1650 | 899 | 3002 | 2250 | 1232 | 4082 | 2650 | 1454 | 4802 |
| 1060 | 571 | 1940 | 1660 | 904 | 3020 | 2260 | 1238 | 4100 | 2660 | 1460 | 4820 |
| 1070 | 577 | 1958 | 1670 | 910 | 3038 | 2270 | 1243 | 4118 | 2670 | 1466 | 4838 |
| 1080 | 582 | 1976 | 1680 | 916 | 3056 | 2280 | 1249 | 4136 | 2680 | 1471 | 4856 |
| 1090 | 588 | 1994 | 1690 | 921 | 3074 | 2290 | 1254 | 4154 | 2690 | 1477 | 4874 |
| 1100 | 593 | 2012 | 1700 | 927 | 3092 | 2300 | 1260 | 4172 | 2700 | 1482 | 4892 |
| 1110 | 599 | 2030 | 1710 | 932 | 3110 | 2310 | 1266 | 4190 | 2710 | 1488 | 4910 |
| 1120 | 604 | 2048 | 1720 | 938 | 3128 | 2320 | 1271 | 4208 | 2720 | 1493 | 4928 |
| 1130 | 610 | 2066 | 1730 | 943 | 3146 | 2330 | 1277 | 4226 | 2730 | 1499 | 4946 |
| 1140 | 616 | 2084 | 1740 | 949 | 3164 | 2340 | 1282 | 4244 | 2740 | 1504 | 4964 |
| 1150 | 621 | 2102 | 1750 | 954 | 3182 | 2350 | 1288 | 4262 | 2750 | 1510 | 4982 |
| 1160 | 627 | 2120 | 1760 | 960 | 3200 | 2360 | 1293 | 4280 | 2760 | 1516 | 5000 |
| 1170 | 632 | 2138 | 1770 | 966 | 3218 | 2370 | 1299 | 4298 | 2770 | 1521 | 5018 |
| 1180 | 638 | 2156 | 1780 | 971 | 3236 | 2380 | 1304 | 4316 | 2780 | 1527 | 5036 |
| 1190 | 643 | 2174 | 1790 | 977 | 3254 | 2390 | 1310 | 4334 | 2790 | 1532 | 5054 |
| 1200 | 649 | 2192 | 1800 | 982 | 3272 | 2400 | 1316 | 4352 | 2800 | 1538 | 5072 |
| 1210 | 654 | 2210 | 1810 | 988 | 3290 | 2410 | 1321 | 4370 | 2810 | 1543 | 5090 |
| 1220 | 660 | 2228 | 1820 | 993 | 3308 | 2420 | 1327 | 4388 | 2820 | 1549 | 5108 |
| 1230 | 666 | 2246 | 1830 | 999 | 3326 | 2430 | 1332 | 4406 | 2830 | 1554 | 5126 |
| 1240 | 671 | 2264 | 1840 | 1004 | 3344 | 2440 | 1338 | 4424 | 2840 | 1560 | 5144 |
| 1250 | 677 | 2282 | 1850 | 1010 | 3362 | 2450 | 1343 | 4442 | 2850 | 1566 | 5162 |
| 1260 | 682 | 2300 | 1860 | 1016 | 3380 | 2460 | 1349 | 4460 | 2860 | 1571 | 5180 |
| 1270 | 688 | 2318 | 1870 | 1021 | 3398 | 2470 | 1354 | 4478 | 2870 | 1577 | 5198 |
| 1280 | 693 | 2336 | 1880 | 1027 | 3416 | 2480 | 1360 | 4496 | 2880 | 1582 | 5216 |
| 1290 | 699 | 2354 | 1890 | 1032 | 3434 | 2490 | 1366 | 4514 | 2890 | 1588 | 5234 |
| 1300 | 704 | 2372 | 1900 | 1038 | 3452 | 2500 | 1371 | 4532 | 2900 | 1593 | 5252 |
| 1310 | 710 | 2390 | 1910 | 1043 | 3470 | 2510 | 1377 | 4550 | 2910 | 1599 | 5270 |
| 1320 | 716 | 2408 | 1920 | 1049 | 3488 | 2520 | 1382 | 4568 | 2920 | 1604 | 5280 |
| 1330 | 721 | 2426 | 1930 | 1054 | 3506 | 2530 | 1388 | 4586 | 2930 | 1610 | 5306 |
| 1340 | 727 | 2444 | 1940 | 1060 | 3524 | 2540 | 1393 | 4604 | 2940 | 1616 | 5324 |
| 1350 | 732 | 2462 | 1950 | 1066 | 3542 | 2550 | 1399 | 4622 | 2950 | 1621 | 5342 |
| 1360 | 738 | 2480 | 1960 | 1071 | 3560 | 2560 | 1404 | 4640 | 2960 | 1627 | 5360 |
| 1370 | 743 | 2498 | 1970 | 1077 | 3578 | 2570 | 1410 | 4658 | 2970 | 1632 | 5378 |
| 1380 | 749 | 2516 | 1980 | 1082 | 3596 | 2580 | 1416 | 4676 | 2980 | 1638 | 5396 |
| 1390 | 754 | 2534 | 1990 | 1088 | 3614 | 2590 | 1421 | 4694 | 2990 | 1643 | 5414 |
| 1400 | 760 | 2552 | 2000 | 1093 | 3632 | 2600 | 1427 | 4712 | 3000 | 1649 | 5432 |
| 1410 | 766 | 2570 | 2010 | 1099 | 3650 | | | | | | |
| 1420 | 771 | 2588 | 2020 | 1104 | 3668 | | | | | | |
| 1430 | 777 | 2606 | 2030 | 1110 | 3686 | | | | | | |
| 1440 | 782 | 2624 | 2040 | 1116 | 3704 | | | | | | |
| 1450 | 788 | 2642 | 2050 | 1121 | 3722 | | | | | | |
| 1460 | 793 | 2660 | 2060 | 1127 | 3740 | | | | | | |
| 1470 | 799 | 2678 | 2070 | 1132 | 3758 | | | | | | |
| 1480 | 804 | 2696 | 2080 | 1138 | 3776 | | | | | | |
| 1490 | 810 | 2714 | 2090 | 1143 | 3794 | | | | | | |
| 1500 | 816 | 2732 | 2100 | 1149 | 3812 | | | | | | |
| 1510 | 821 | 2750 | 2110 | 1154 | 3830 | | | | | | |
| 1520 | 827 | 2768 | 2120 | 1160 | 3848 | | | | | | |
| 1530 | 832 | 2786 | 2130 | 1166 | 3866 | | | | | | |
| 1540 | 838 | 2804 | 2140 | 1171 | 3884 | | | | | | |
| 1550 | 843 | 2822 | 2150 | 1177 | 3902 | | | | | | |
| 1560 | 849 | 2840 | 2160 | 1182 | 3920 | | | | | | |
| 1570 | 854 | 2858 | 2170 | 1188 | 3938 | | | | | | |
| 1580 | 860 | 2876 | 2180 | 1193 | 3956 | | | | | | |
| 1590 | 866 | 2894 | 2190 | 1199 | 3974 | | | | | | |
| 1600 | 871 | 2912 | 2200 | 1204 | 3992 | | | | | | |

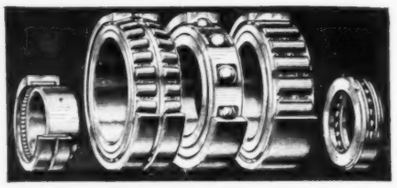
**Factors for interpolation**

| Temp., °C. or °F. | °C. | °F. | Temp., °C. or °F. | °C. | °F. |
|---|---|---|---|---|---|
| 1 | 0.56 | 1.8 | 6 | 3.33 | 10.8 |
| 2 | 1.11 | 3.6 | 7 | 3.89 | 12.6 |
| 3 | 1.67 | 5.4 | 8 | 4.44 | 14.4 |
| 4 | 2.22 | 7.2 | 9 | 5.00 | 16.2 |
| 5 | 2.78 | 9.0 | 10 | 5.56 | 18.0 |

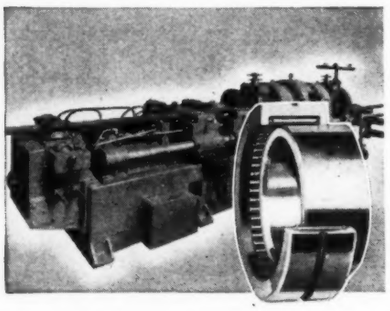
NOTE: Numbers in the column "Temperature, °C. or °F." refers to the temperature in either Centigrade or Fahrenheit which it is desired to convert. The columns headed "°C." and "°F." contain the equivalent temperatures to those given in the first column.

# IN THE NEWS
## WITH BANTAM BEARINGS

**ON THE 1000-POUND LANDING GEAR** of many giant bombers, you will find Bantam Needle Bearings contributing to smooth, dependable operation of the "Up-Latch" which locks the gear in flight position. This is just one of the ways that the many types of Bantam Bearings are helping to assure the successful functioning both of the weapons for Victory and of the machines that produce them.

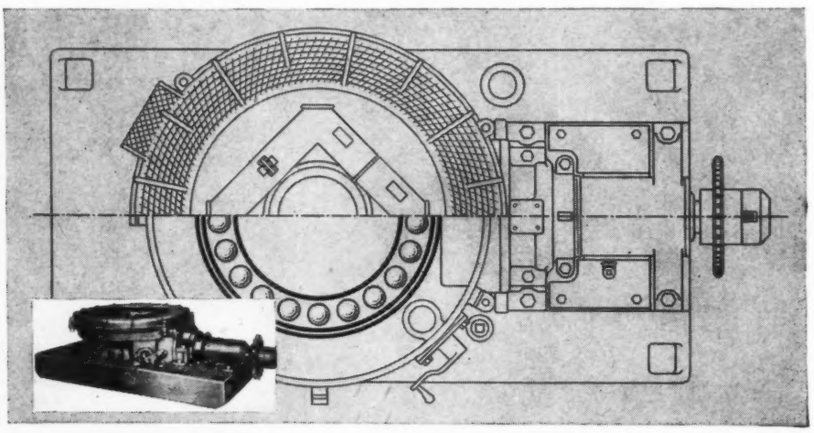


**BANTAM'S ENGINEERING COOPERATION** is especially valuable in meeting new and unusual requirements. Bantam makes every major type of anti-friction bearing—straight roller, tapered roller, needle, and ball. Bantam engineers aid in the selection of the most suitable type, or design special bearings to meet your requirements. If you have a difficult bearing problem, TURN TO BANTAM.



**SPEED AND ACCURACY** characterize the operation of centerless bar turners built by The Medart Company and used for precision finishing of bars and tubular products. In an ingenious feeding device combining hydraulic and mechanical action, standard Bantam Quill Bearings serve a novel application in cam rollers on the feeding grip jaws.

**RIGID LABORATORY CONTROL** contributes to the successful performance of Bantam Quill Bearings—the unusual anti-friction bearings that combine high radial load capacity, small size, ease of installation and lubrication. Samples from daily production runs are regularly tested for adherence to metallurgical and machining specifications. For further information on the Quill Bearing, write for Bulletin P-104.



**OIL FOR A WAR OF MACHINES** is needed in ever-increasing quantities—and the drill bits are turning faster, boring deeper into the earth. This cut-away view shows one of The Wheland Company's High-speed Oil Bath Rotaries, designed to meet every requirement of present-day drilling practice—and large Bantam Precision Ball Bearings are used to take both thrust and radial loads on the rotary table.

**BANTAM BEARINGS**

**STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL**

**BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA**

## 24-HOUR CAPACITY* OF 4-IN. BY 1-IN. ORIFICE PLATE—FLANGE CONNECTIONS

| Pressure, lb. per sq. in. ga. | Differential, in. of water | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 10 | 71 | 100 | 141 | 173 | 199 | 223 | 244 | 264 | 282 | 299 | 315 |
| 20 | 84 | 118 | 167 | 205 | 237 | 265 | 290 | 313 | 335 | 355 | 374 |
| 30 | 95 | 134 | 190 | 233 | 269 | 301 | 329 | 356 | 380 | 403 | 425 |
| 40 | 105 | 149 | 210 | 258 | 298 | 333 | 365 | 394 | 421 | 447 | 471 |
| 50 | 114 | 162 | 229 | 280 | 324 | 362 | 397 | 428 | 458 | 486 | 512 |
| 60 | 123 | 174 | 246 | 301 | 348 | 389 | 426 | 461 | 492 | 522 | 550 |
| 70 | 131 | 185 | 262 | 321 | 371 | 415 | 454 | 490 | 524 | 556 | 586 |
| 80 | 139 | 196 | 277 | 340 | 392 | 438 | 480 | 519 | 555 | 588 | 620 |
| 90 | 146 | 206 | 292 | 357 | 412 | 461 | 505 | 546 | 583 | 619 | 652 |
| 100 | 153 | 216 | 305 | 374 | 432 | 483 | 529 | 571 | 611 | 648 | 683 |
| 110 | 159 | 225 | 318 | 390 | 450 | 503 | 551 | 596 | 637 | 675 | 712 |
| 120 | 165 | 234 | 331 | 405 | 468 | 523 | 573 | 619 | 662 | 702 | 740 |
| 130 | 171 | 243 | 343 | 420 | 485 | 542 | 594 | 641 | 686 | 728 | 767 |
| 140 | 177 | 251 | 355 | 434 | 502 | 561 | 614 | 664 | 709 | 752 | 793 |
| 150 | 183 | 259 | 366 | 448 | 517 | 579 | 634 | 685 | 732 | 776 | 818 |
| 160 | 188 | 266 | 377 | 462 | 533 | 596 | 653 | 705 | 754 | 800 | 843 |
| 170 | 194 | 274 | 388 | 475 | 548 | 613 | 671 | 725 | 775 | 822 | 867 |
| 180 | 199 | 281 | 398 | 487 | 563 | 629 | 689 | 745 | 796 | 844 | 890 |
| 190 | 204 | 289 | 408 | 500 | 577 | 645 | 706 | 764 | 816 | 865 | 913 |
| 200 | 209 | 295 | 418 | 512 | 591 | 660 | 724 | 782 | 836 | 886 | 934 |
| 210 | 214 | 302 | 428 | 524 | 605 | 676 | 740 | 800 | 855 | 907 | 956 |
| 220 | 218 | 309 | 437 | 535 | 618 | 691 | 757 | 817 | 874 | 927 | 977 |
| 230 | 223 | 316 | 446 | 546 | 631 | 705 | 773 | 835 | 892 | 946 | 997 |
| 240 | 228 | 322 | 455 | 557 | 644 | 720 | 788 | 851 | 911 | 966 | 1018 |
| 250 | 232 | 328 | 464 | 568 | 656 | 734 | 804 | 868 | 928 | 985 | 1038 |
| 260 | 236 | 334 | 473 | 579 | 669 | 747 | 819 | 884 | 946 | 1003 | 1057 |
| 270 | 241 | 340 | 481 | 589 | 681 | 761 | 833 | 900 | 962 | 1021 | 1076 |
| 280 | 245 | 346 | 490 | 600 | 692 | 774 | 848 | 916 | 980 | 1039 | 1095 |
| 290 | 249 | 352 | 498 | 610 | 704 | 787 | 862 | 932 | 996 | 1056 | 1114 |
| 300 | 253 | 358 | 506 | 620 | 715 | 800 | 876 | 947 | 1012 | 1073 | 1131 |
| 310 | 257 | 363 | 514 | 630 | 727 | 813 | 890 | 962 | 1028 | 1091 | 1149 |
| 320 | 261 | 369 | 522 | 639 | 738 | 825 | 904 | 976 | 1044 | 1107 | 1167 |
| 330 | 265 | 375 | 530 | 648 | 749 | 837 | 917 | 991 | 1059 | 1124 | 1184 |
| 340 | 269 | 380 | 537 | 658 | 760 | 849 | 930 | 1005 | 1075 | 1140 | 1202 |
| 350 | 272 | 385 | 545 | 668 | 770 | 862 | 944 | 1019 | 1089 | 1156 | 1218 |
| 360 | 276 | 390 | 552 | 676 | 781 | 873 | 957 | 1033 | 1105 | 1172 | 1234 |
| 370 | 280 | 396 | 560 | 685 | 791 | 884 | 969 | 1047 | 1119 | 1187 | 1251 |
| 380 | 283 | 401 | 567 | 694 | 802 | 896 | 981 | 1061 | 1133 | 1202 | 1267 |
| 390 | 287 | 406 | 574 | 703 | 812 | 907 | 994 | 1073 | 1148 | 1218 | 1283 |
| 400 | 290 | 411 | 581 | 712 | 821 | 918 | 1006 | 1087 | 1162 | 1232 | 1299 |
| 410 | 294 | 416 | 588 | 720 | 832 | 930 | 1019 | 1100 | 1176 | 1247 | 1315 |
| 420 | 297 | 421 | 595 | 729 | 841 | 941 | 1030 | 1113 | 1190 | 1262 | 1330 |
| 430 | 301 | 425 | 602 | 737 | 851 | 951 | 1042 | 1126 | 1204 | 1276 | 1345 |
| 440 | 304 | 430 | 608 | 745 | 860 | 962 | 1054 | 1138 | 1217 | 1290 | 1361 |
| 450 | 308 | 435 | 615 | 753 | 870 | 973 | 1065 | 1151 | 1230 | 1304 | 1375 |
| 460 | 311 | 440 | 622 | 761 | 879 | 983 | 1077 | 1163 | 1243 | 1318 | 1390 |
| 470 | 314 | 444 | 628 | 769 | 888 | 993 | 1088 | 1175 | 1257 | 1332 | 1405 |
| 480 | 317 | 449 | 635 | 777 | 897 | 1003 | 1099 | 1187 | 1269 | 1346 | 1419 |
| 490 | 320 | 453 | 641 | 785 | 906 | 1013 | 1110 | 1199 | 1282 | 1360 | 1433 |
| 500 | 324 | 458 | 647 | 793 | 915 | 1024 | 1121 | 1211 | 1295 | 1373 | 1447 |

4-in. by 1-in. orifice plate size, flange connection.
*Million cu. ft. based on (4 oz.) 14.4 lbs. per sq. in., 0.60 gravity, and 60°F. temperature.

1 hour coefficient = 265.9
24 hour coefficient = 6381.6

# "Store welding electrodes in a dry place— they will keep indefinitely if properly cared for"

Always keep electrodes in a dry place — on a clean shelf or rack, or at least off the floor. Don't expose them to moisture, keep them away from sweating pipes and open windows. If by accident a box of electrodes should get wet, spread them out to dry immediately.

Follow these simple precautions together with those enumerated at the right — fight waste to speed victory.

A booklet of shop bulletins illustrating "do's" and "dont's" has been prepared to help your welding operators get the most out of every electrode. We'll gladly send you as many copies as you can use.

**WELDING ELECTRODES ARE SCARCE**
**Help Prevent Waste**

- Do not bend electrodes unless absolutely necessary
- Use electrodes down to a 2-inch stub
- Fit joints properly before welding
- Make legs of fillet welds equal
- Make the face of fillet welds flat

**Air Reduction**

*General Offices:*
60 EAST 42nd STREET, NEW YORK, N. Y.
IN TEXAS
MAGNOLIA - AIRCO GAS PRODUCTS CO.

AIRCO WILSON

**OXYGEN IS PRODUCTION — *Don't Waste it!***

## PUMP EQUIVALENTS — GAL. PER MINUTE

| Gal. per minute | Gal. per hour | Gal. per day* | Cu. ft. per second | Cu. ft. per minute | Cu. ft. per hour | Cu. ft. per day* | †Bbl. per minute | Bbl. per hour | Bbl. per day* |
|---|---|---|---|---|---|---|---|---|---|
| 200 | 12.00 | 288,000 | | 26.67 | 1600 | 38,400 | 4.76 | 285 | 6,857 |
| 205 | 12,300 | 295,200 | | 27.33 | 1640 | 39,360 | 4.88 | 293 | 7,028 |
| 210 | 12,600 | 302,400 | | 28.00 | 1680 | 40,320 | 5.00 | 300 | 7,199 |
| 215 | 12,900 | 309,600 | | 28.66 | 1720 | 41,280 | 5.12 | 307 | 7,371 |
| 220 | 13,200 | 316,800 | | 29.33 | 1760 | 42,240 | 5.24 | 315 | 7,543 |
| 225 | 13,500 | 324,000 | 0.50 | 30.00 | 1800 | 43,200 | 5.36 | 322 | 7,714 |
| 230 | 13,800 | 331,200 | | 30.67 | 1840 | 44,160 | 5.48 | 329 | 7,885 |
| 235 | 14,100 | 338,400 | | 31.33 | 1880 | 45,120 | 5.59 | 336 | 8,056 |
| 240 | 14,400 | 345,600 | | 32.00 | 1920 | 46,080 | 5.71 | 343 | 8,228 |
| 245 | 14,700 | 352,800 | | 32.67 | 1960 | 47,040 | 5.83 | 350 | 8,399 |
| 250 | 15,000 | 360,000 | | 33.34 | 2000 | 48,000 | 5.95 | 358 | 8,571 |
| 255 | 15,300 | 367,200 | | 34.00 | 2040 | 48,960 | 6.07 | 365 | 8,742 |
| 260 | 15,600 | 374,400 | | 34.67 | 2080 | 49,920 | 6.19 | 371 | 8,914 |
| 265 | 15,900 | 381,600 | | 35.34 | 2120 | 50,880 | 6.31 | 378 | 9,085 |
| 270 | 16,200 | 388,800 | 0.60 | 36.00 | 2160 | 51,840 | 6.43 | 386 | 9,256 |
| 275 | 16,500 | 396,000 | | 36.67 | 2200 | 52,800 | 6.55 | 393 | 9,428 |
| 280 | 16,800 | 403,200 | | 37.34 | 2240 | 53,760 | 6.67 | 400 | 9,599 |
| 285 | 17,100 | 410,400 | | 38.00 | 2280 | 54,720 | 6.78 | 407 | 9,771 |
| 290 | 17,400 | 417,600 | | 38.67 | 2320 | 55,680 | 6.90 | 414 | 9,942 |
| 295 | 17,700 | 424,800 | | 39.34 | 2360 | 56,640 | 7.02 | 421 | 10,114 |
| 300 | 18,000 | 432,000 | | 40.00 | 2400 | 57,600 | 7.14 | 429 | 10,285 |
| 305 | 18,300 | 439,200 | | 40.67 | 2440 | 58,560 | 7.26 | 436 | 10,456 |
| 310 | 18,600 | 446,400 | | 41.34 | 2480 | 59,520 | 7.38 | 443 | 10,628 |
| 315 | 18,900 | 453,600 | 0.70 | 42.00 | 2520 | 60,480 | 7.50 | 450 | 10,799 |
| 320 | 19,200 | 460,800 | | 42.67 | 2560 | 61,640 | 7.62 | 457 | 10,971 |
| 325 | 19,500 | 468,000 | | 43.34 | 2600 | 62,400 | 7.74 | 464 | 11,142 |
| 330 | 19,800 | 475,200 | | 44.00 | 2640 | 63,360 | 7.86 | 471 | 11,314 |
| 335 | 20,100 | 482,400 | | 44.67 | 2680 | 64,320 | 7.98 | 479 | 11,485 |
| 340 | 20,400 | 489,600 | | 45.34 | 2720 | 65,280 | 8.09 | 486 | 11,656 |
| 345 | 20,700 | 496,800 | | 46.00 | 2760 | 66,240 | 8.21 | 493 | 11,828 |
| 350 | 21,000 | 504,000 | | 46.67 | 2800 | 67,200 | 8.33 | 500 | 11,999 |
| 355 | 21,300 | 511,200 | | 47.34 | 2840 | 68,160 | 8.45 | 507 | 12,171 |
| 360 | 21,600 | 518,400 | 0.80 | 48.00 | 2880 | 69,120 | 8.57 | 514 | 12,342 |
| 365 | 21,900 | 525,600 | | 48.67 | 2920 | 70,080 | 8.69 | 521 | 12,514 |
| 370 | 22,200 | 532,800 | | 49.34 | 2960 | 71,040 | 8.81 | 529 | 12,685 |
| 375 | 22,500 | 540,000 | | 50.00 | 3000 | 72,000 | 8.93 | 536 | 12,856 |
| 380 | 22,800 | 547,200 | | 50.67 | 3040 | 72,960 | 9.05 | 543 | 13,028 |
| 385 | 23,100 | 554,400 | | 51.34 | 3080 | 73,920 | 9.17 | 550 | 13,199 |
| 390 | 23,400 | 561,600 | | 52.00 | 3120 | 74,880 | 9.29 | 557 | 13,371 |
| 395 | 23,700 | 568,800 | | 52.67 | 3160 | 75,840 | 9.40 | 564 | 13,542 |
| 400 | 24,000 | 576,000 | 0.90 | 53.34 | 3200 | 76,800 | 9.52 | 572 | 13,714 |
| 405 | 24,300 | 583,200 | | 54.00 | 3240 | 77,760 | 9.64 | 579 | 13,885 |
| 410 | 24,600 | 590,400 | | 54.67 | 3280 | 78,720 | 9.76 | 586 | 14,056 |
| 415 | 24,900 | 597,600 | | 55.34 | 3320 | 79,680 | 9.88 | 593 | 14,228 |
| 420 | 25,200 | 604,800 | | 56.00 | 3360 | 80,640 | 10.0 | 600 | 14,399 |
| 425 | 25,500 | 612,000 | | 56.67 | 3400 | 81,600 | 10.1 | 607 | 14,571 |
| 430 | 25,800 | 619,200 | | 57.34 | 3440 | 82,560 | 10.2 | 614 | 14,742 |
| 435 | 26,100 | 626,400 | | 58.00 | 3480 | 83,520 | 10.4 | 622 | 14,914 |
| 440 | 26,400 | 633,600 | | 58.67 | 3520 | 84,480 | 10.5 | 629 | 15,085 |
| 445 | 26,700 | 640,800 | | 59.34 | 3560 | 85,440 | 10.6 | 636 | 15,257 |

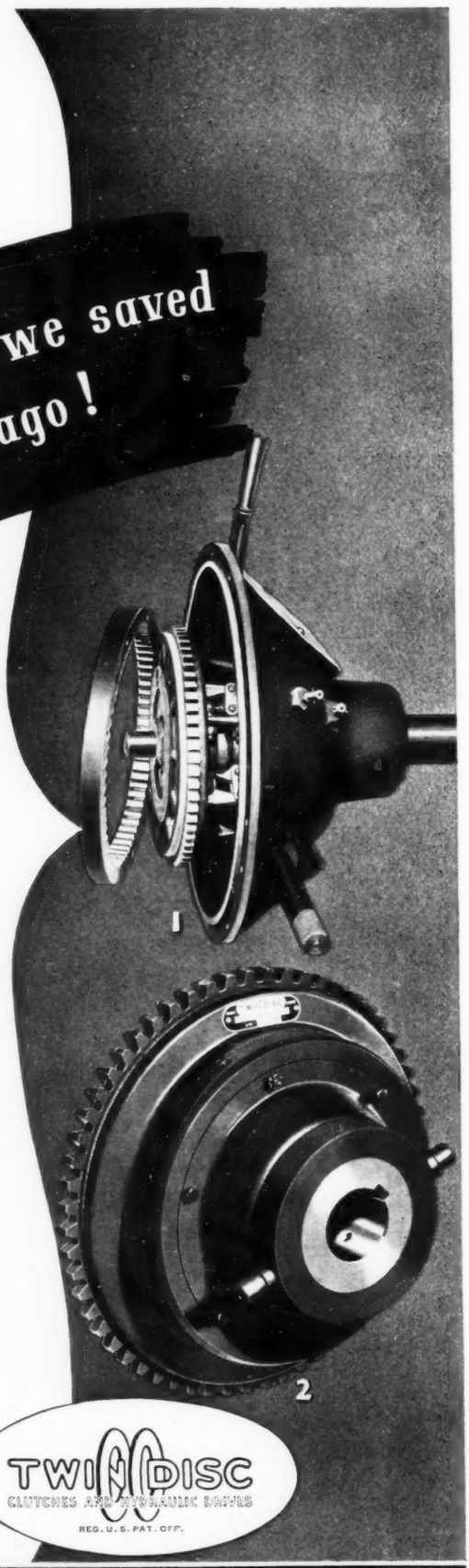
*24 hr. day
†42 gal. bbl.

# Here's some *Time* we saved for you years ago!

● Sounds a little far-fetched, doesn't it? But we mean it literally. Right now—today, when time is more precious than ever, Twin Disc can say to you, "Here's some time we saved for you years ago."

It happened this way. Oil men everywhere know about Twin Disc Clutches—their performance in the field—how they are listed as standard equipment on 95% of oil-field, power driven machinery. Operators of cable tool and rotary rigs, on pumps, are all familiar with Twin Disc Clutch construction, its ease of operation and adjustment . . . its low maintenance cost. The predominance of Twin Disc Clutches in your business is not accidental. It resulted from an early demonstrated ability to stand up under the terrific beatings which the men and machines producing the nation's life blood have always taken.

This predominance of Twin Disc Clutches in the oil fields was directly responsible for the establishment of three Twin Disc direct factory branches in the mid-continent area, of parts stations located in every active center. This service organization stands ready, at all times, to furnish Twin Disc Clutch parts in the shortest possible time—why not make full use of its facilities? And remember that these complete service facilities exist today because years ago, the Twin Disc Clutch Company went further than merely fitting a clutch to the engine or machine . . . through a close association with the machine builder and user of Twin Disc Clutches they were "Built to Fit the Job—Today's Job" . . . that's why we say: "Here's some time we saved for you years ago."




**1.** *Twin Disc Power Take-off for engines having up to 285 hp. output. Sizes: with single plate clutches, 6½" to 24"; double plate, 11½" to 18" Housing sizes: No. 6 S.A.E. to No 00 S.A.E.*

**2.** *Twin Disc Model E Clutches, heavy-duty, enclosed type. Sizes: 14" to 42" in single or two-plate assemblies.*

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U. S. PAT. OFF.

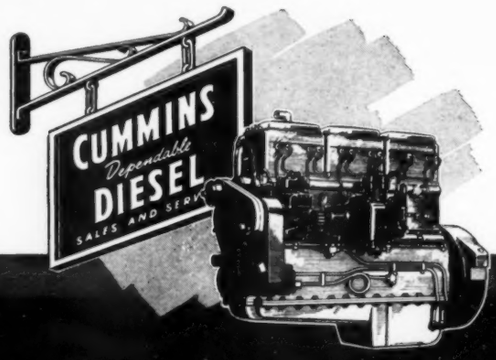
**TWIN DISC CLUTCH COMPANY • RACINE, WISCONSIN**

## 24-HOUR CAPACITY* OF 4-IN. BY 1¼-IN. ORIFICE PLATE—FLANGE CONNECTIONS

| Pressure, lb. per sq. in. ga. | Differential, in. of water | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 10 | 110 | 156 | 220 | 270 | 312 | 348 | 382 | 412 | 441 | 467 | 493 |
| 20 | 131 | 185 | 262 | 320 | 370 | 414 | 453 | 489 | 523 | 555 | 585 |
| 30 | 149 | 210 | 297 | 364 | 420 | 470 | 515 | 556 | 594 | 630 | 664 |
| 40 | 164 | 233 | 329 | 403 | 465 | 520 | 570 | 615 | 658 | 698 | 736 |
| 50 | 179 | 253 | 358 | 438 | 506 | 566 | 620 | 670 | 716 | 759 | 800 |
| 60 | 192 | 272 | 385 | 471 | 544 | 608 | 666 | 720 | 769 | 816 | 860 |
| 70 | 205 | 290 | 410 | 502 | 579 | 648 | 710 | 766 | 819 | 869 | 916 |
| 80 | 217 | 306 | 433 | 531 | 613 | 685 | 750 | 811 | 867 | 919 | 969 |
| 90 | 228 | 322 | 456 | 558 | 644 | 720 | 789 | 853 | 911 | 967 | 1019 |
| 100 | 239 | 337 | 477 | 584 | 675 | 754 | 826 | 892 | 954 | 1012 | 1067 |
| 110 | 249 | 352 | 497 | 609 | 703 | 786 | 861 | 931 | 995 | 1055 | 1112 |
| 120 | 258 | 366 | 517 | 633 | 731 | 818 | 895 | 967 | 1034 | 1097 | 1156 |
| 130 | 268 | 379 | 536 | 656 | 758 | 847 | 928 | 1002 | 1072 | 1137 | 1199 |
| 140 | 277 | 392 | 554 | 679 | 784 | 876 | 960 | 1037 | 1108 | 1176 | 1240 |
| 150 | 286 | 404 | 572 | 700 | 809 | 904 | 990 | 1070 | 1144 | 1213 | 1278 |
| 160 | 294 | 416 | 589 | 721 | 833 | 931 | 1020 | 1102 | 1178 | 1249 | 1317 |
| 170 | 303 | 428 | 606 | 742 | 856 | 958 | 1049 | 1133 | 1212 | 1284 | 1354 |
| 180 | 311 | 440 | 622 | 762 | 879 | 983 | 1077 | 1164 | 1244 | 1319 | 1390 |
| 190 | 319 | 451 | 637 | 781 | 901 | 1008 | 1104 | 1193 | 1275 | 1352 | 1426 |
| 200 | 326 | 462 | 653 | 800 | 924 | 1032 | 1131 | 1222 | 1306 | 1385 | 1460 |
| 210 | 334 | 472 | 668 | 818 | 945 | 1056 | 1157 | 1249 | 1336 | 1417 | 1494 |
| 220 | 341 | 483 | 683 | 836 | 966 | 1080 | 1183 | 1277 | 1365 | 1448 | 1527 |
| 230 | 349 | 493 | 697 | 854 | 986 | 1102 | 1208 | 1304 | 1394 | 1479 | 1559 |
| 240 | 356 | 503 | 711 | 871 | 1006 | 1125 | 1232 | 1330 | 1423 | 1509 | 1591 |
| 250 | 363 | 513 | 725 | 889 | 1025 | 1147 | 1256 | 1356 | 1450 | 1539 | 1621 |
| 260 | 369 | 523 | 739 | 904 | 1045 | 1168 | 1279 | 1382 | 1478 | 1567 | 1652 |
| 270 | 376 | 532 | 752 | 921 | 1064 | 1189 | 1302 | 1407 | 1504 | 1596 | 1681 |
| 280 | 383 | 541 | 765 | 937 | 1082 | 1210 | 1325 | 1432 | 1531 | 1623 | 1711 |
| 290 | 389 | 550 | 778 | 953 | 1099 | 1231 | 1347 | 1456 | 1557 | 1650 | 1740 |
| 300 | 396 | 559 | 791 | 968 | 1118 | 1250 | 1369 | 1480 | 1582 | 1677 | 1768 |
| 310 | 402 | 568 | 804 | 984 | 1136 | 1270 | 1391 | 1503 | 1606 | 1704 | 1796 |
| 320 | 408 | 576 | 816 | 999 | 1154 | 1289 | 1412 | 1526 | 1631 | 1731 | 1824 |
| 330 | 414 | 585 | 828 | 1013 | 1171 | 1308 | 1433 | 1549 | 1655 | 1756 | 1851 |
| 340 | 420 | 593 | 840 | 1028 | 1188 | 1327 | 1454 | 1571 | 1679 | 1781 | 1878 |
| 350 | 426 | 602 | 852 | 1045 | 1204 | 1346 | 1475 | 1593 | 1702 | 1806 | 1904 |
| 360 | 432 | 610 | 863 | 1057 | 1221 | 1364 | 1495 | 1614 | 1726 | 1831 | 1930 |
| 370 | 437 | 618 | 875 | 1071 | 1237 | 1382 | 1515 | 1635 | 1749 | 1855 | 1956 |
| 380 | 443 | 626 | 886 | 1085 | 1252 | 1400 | 1534 | 1657 | 1771 | 1879 | 1980 |
| 390 | 449 | 634 | 896 | 1098 | 1268 | 1418 | 1554 | 1677 | 1794 | 1903 | 2005 |
| 400 | 454 | 642 | 907 | 1112 | 1283 | 1435 | 1573 | 1698 | 1816 | 1926 | 2030 |
| 410 | 460 | 650 | 918 | 1125 | 1299 | 1453 | 1592 | 1719 | 1838 | 1949 | 2054 |
| 420 | 465 | 657 | 929 | 1139 | 1314 | 1470 | 1610 | 1739 | 1859 | 1971 | 2078 |
| 430 | 470 | 665 | 940 | 1152 | 1329 | 1487 | 1629 | 1759 | 1881 | 1994 | 2102 |
| 440 | 476 | 672 | 950 | 1165 | 1344 | 1504 | 1647 | 1778 | 1902 | 2016 | 2126 |
| 450 | 481 | 680 | 961 | 1177 | 1359 | 1520 | 1664 | 1798 | 1922 | 2038 | 2149 |
| 460 | 486 | 687 | 971 | 1190 | 1374 | 1536 | 1682 | 1817 | 1943 | 2060 | 2172 |
| 470 | 491 | 694 | 981 | 1202 | 1388 | 1552 | 1700 | 1836 | 1963 | 2082 | 2195 |
| 480 | 496 | 701 | 991 | 1215 | 1402 | 1568 | 1717 | 1855 | 1981 | 2103 | 2218 |
| 490 | 501 | 708 | 1001 | 1227 | 1416 | 1584 | 1735 | 1874 | 2003 | 2125 | 2240 |
| 500 | 506 | 715 | 1011 | 1239 | 1430 | 1600 | 1752 | 1893 | 2023 | 2146 | 2262 |

4-in. x 1¼-in. orifice plate size, flange connection.
*Million cu. ft. based on (4 oz.) 14.4 lbs. per sq. in., 0.60 gravity, and 60°F. temperature.

1 hour coefficient = 415.5
24 hour coefficient = 9972.0




# ARE YOU TAKING FULL ADVANTAGE OF THE SERVICES OFFERED BY YOUR *Cummins Dealer*?

## A CLEARING HOUSE FOR SERVICE HELPS

As a result of the war emergency, short-cuts and new ideas are being continually discovered by Cummins maintenance and service men throughout the country. Because your Cummins dealer is in constant touch, not only with the Cummins factory, but with a nation-wide dealer organization, he is a clearing house for the best practices on parts reclamation. He can show you how to get the maximum use out of every part.

## TRAINING NEW MECHANICS

Are your new men thoroughly familiar with Cummins' program of preventive maintenance? Do they completely understand the best methods of servicing your engines? Your Cummins dealer will welcome the opportunity to work with your mechanics . . . make certain their information is up-to-date . . . keep it up-to-date with Service Bulletins and the latest Operator's Manuals. A complete maintenance and service training program is available for any mechanic unfamiliar with the care and operation of the Cummins Diesel. Talk to your dealer about it.

## MAINTENANCE SERVICE

If you do not employ your own mechanics, your Cummins dealer offers you a complete maintenance service at a moderate cost. Discuss your problems with him.

## REMEMBER THIS

The Cummins Customer Service Policy was built around your needs. Unnecessary duplication of parts stocks is avoided. This assures maximum parts stocks at one centrally located, and easily accessible point. Continuously working with the dealer organization are direct, factory sales and service representatives. This gives you an immediate factory contact, with no red tape . . . "owner-to-dealer-to-factory."

★ ★ ★

*You owe it to yourself to know how we are insuring a better, "after-the-war" diesel . . . one which will do your job at a lower cost, over a longer period, with less maintenance and service. Ask your dealer for the new booklet, "Threshold to the Future" or write direct to the* CUMMINS ENGINE COMPANY, *Columbus, Indiana.*

**MID-CONTINENT SUPPLY COMPANY, Fort Worth, Texas**

**DISTRIBUTORS MID-CONTINENT TERRITORY**

# SOLUTION OF HAZEN AND WILLIAMS FORMULA FOR LARGE CAPACITY LINES

FORMULA:—

$$p^{0.54} = \frac{162.04\ Q\ 9^{0.54}}{cd^{2.63}}$$

Where
P = Pounds per sq. in. friction loss per mile
Q = Discharge in bbls. per hour
g = Specific gravity
d = Inside diameter of pipe in inches

Examples:.

(1) Given: To transport 20,000 Bbls. of 60° Be′ gravity gasoline thru 8″ line pipe having a roughness coefficient C = 145

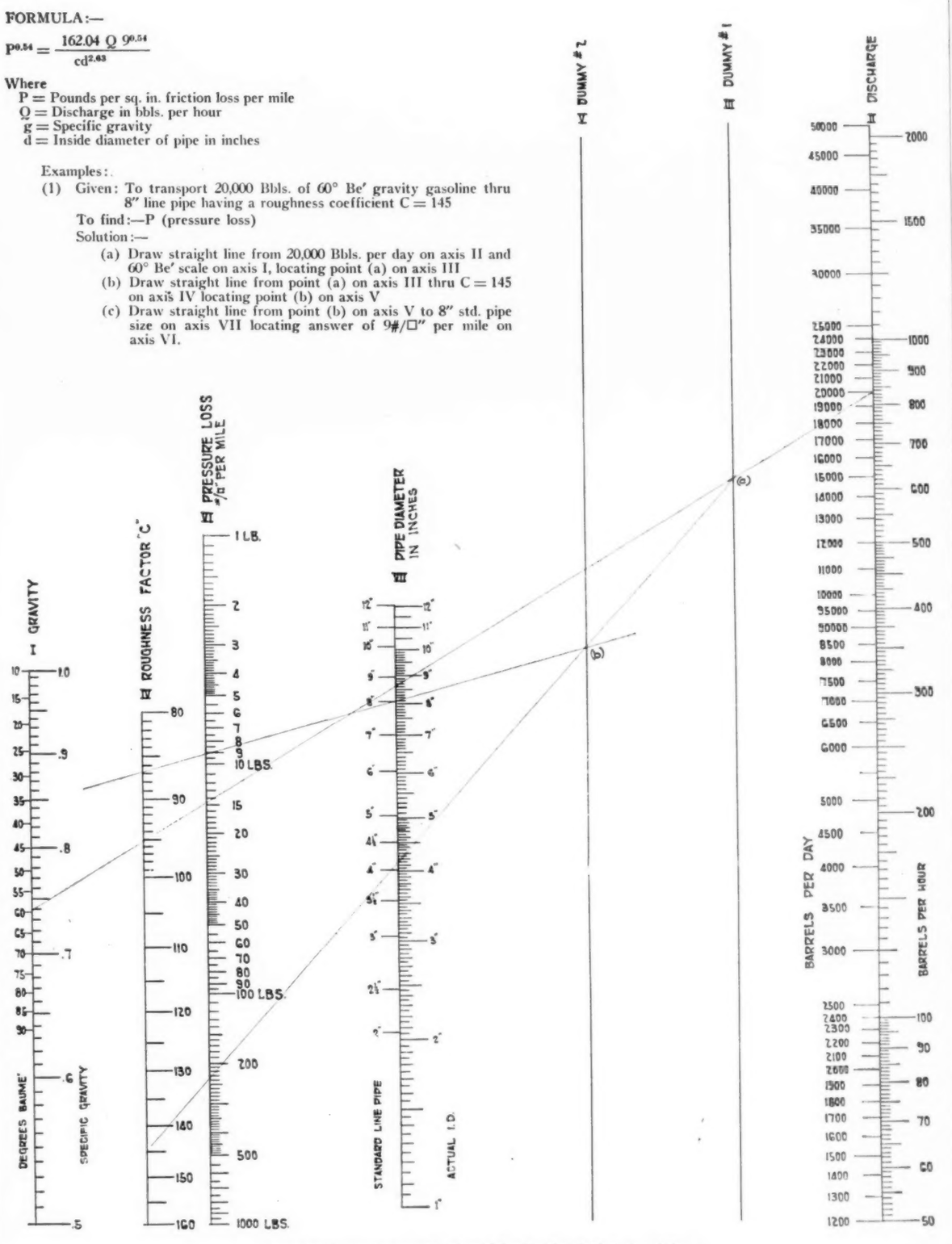
To find:—P (pressure loss)

Solution:—

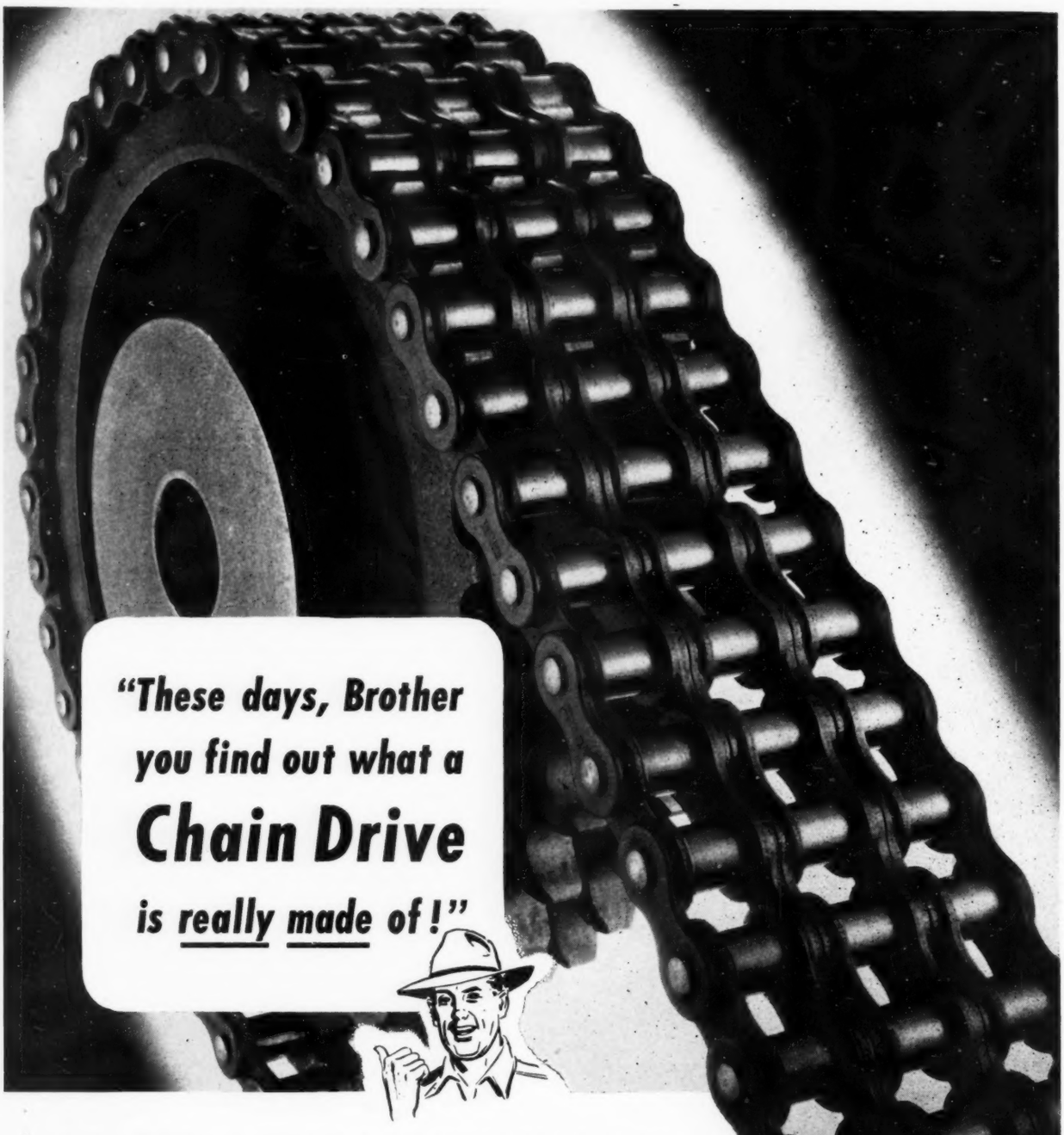
(a) Draw straight line from 20,000 Bbls. per day on axis II and 60° Be′ scale on axis I, locating point (a) on axis III

(b) Draw straight line from point (a) on axis III thru C = 145 on axis IV locating point (b) on axis V

(c) Draw straight line from point (b) on axis V to 8″ std. pipe size on axis VII locating answer of 9#/□″ per mile on axis VI.




*Reproduced by permission of The Natural Gasoline Supply Men's Association*




This is no time for time-outs. And where equipment is driven by Whitney Roller Chains, there's no need to worry about that. For these alloy-armored drives have the advanced design and service-proved steel analysis that provide extra strength and endurance to take the worst beatings handed out by wartime conditions . . . and keep on coming back for more *and more*. Yes, with all your equipment Whitney-driven, you will find out what this chain drive is really made of . . . the stuff to give you positive power-delivery that keeps your production right up to top level.

**Mid-Continent Sales and Service:** *Bull-Stewart Equipment Co., 5219 Grand Ave., Dallas, Texas; Brance-Krachy Co., Inc., 4411 Navigation Blvd., Houston, Texas; Weiss Chain & Transmission Co., 224 East Third St., Tulsa, Okla.; A. D. Guggenheim Co., 227 West 7th Street, Amarillo, Texas; Warford Distributing Co., 319 So. Topeka Ave., Wichita, Kansas; Prager, Inc., 472 Howard Ave., New Orleans, La.*
**Mid-Continent Branch Office:** *The Whitney Chain & Mfg. Co., 2826 Elm Street, Dallas, Texas*
**West Coast:** *Edward D. Maltby Co., 1718 So. Flower St., Los Angeles, Calif.*

# Whitney Roller Chains

**THE WHITNEY CHAIN AND MANUFACTURING COMPANY, HARTFORD, CONNECTICUT**

# CONVERSION OF WELLHEAD PRESSURES TO PRESSURES AT BASE OF GAS COLUMN

L = 500 to 990 ft.

| Avg. length of gas column, L, ft. | Specific gravity, G, = 0.60 | | | | | | Specific gravity, G, = 0.70 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, °F. | | | | | | Temperature, °F. | | | | | |
| | 50 | 60 | 70 | 80 | 90 | 100 | 50 | 60 | 70 | 80 | 90 | 100 |
| 500 | 1.0111 | 1.0109 | 1.0107 | 1.0105 | 1.0103 | 1.0101 | 1.0129 | 1.0127 | 1.0125 | 1.0123 | 1.0120 | 1.0118 |
| 510 | 1.0113 | 1.0111 | 1.0109 | 1.0107 | 1.0105 | 1.0103 | 1.0132 | 1.0130 | 1.0127 | 1.0125 | 1.0123 | 1.0120 |
| 520 | 1.0116 | 1.0113 | 1.0111 | 1.0109 | 1.0107 | 1.0105 | 1.0135 | 1.0132 | 1.0130 | 1.0127 | 1.0125 | 1.0123 |
| 530 | 1.0118 | 1.0116 | 1.0113 | 1.0111 | 1.0109 | 1.0107 | 1.0138 | 1.0135 | 1.0132 | 1.0130 | 1.0127 | 1.0125 |
| 540 | 1.0120 | 1.0118 | 1.0116 | 1.0113 | 1.0111 | 1.0109 | 1.0140 | 1.0137 | 1.0135 | 1.0132 | 1.0130 | 1.0128 |
| 550 | 1.0122 | 1.0120 | 1.0118 | 1.0115 | 1.0113 | 1.0111 | 1.0143 | 1.0140 | 1.0137 | 1.0134 | 1.0132 | 1.0130 |
| 560 | 1.0124 | 1.0122 | 1.0120 | 1.0117 | 1.0115 | 1.0113 | 1.0145 | 1.0143 | 1.0140 | 1.0137 | 1.0135 | 1.0132 |
| 570 | 1.0127 | 1.0124 | 1.0122 | 1.0120 | 1.0117 | 1.0115 | 1.0148 | 1.0145 | 1.0142 | 1.0139 | 1.0137 | 1.0135 |
| 580 | 1.0129 | 1.0126 | 1.0124 | 1.0122 | 1.0120 | 1.0117 | 1.0150 | 1.0148 | 1.0145 | 1.0142 | 1.0139 | 1.0137 |
| 590 | 1.0131 | 1.0129 | 1.0126 | 1.0124 | 1.0121 | 1.0119 | 1.0153 | 1.0150 | 1.0147 | 1.0144 | 1.0142 | 1.0139 |
| 600 | 1.0133 | 1.0131 | 1.0128 | 1.0126 | 1.0124 | 1.0121 | 1.0156 | 1.0153 | 1.0150 | 1.0147 | 1.0144 | 1.0142 |
| 610 | 1.0136 | 1.0133 | 1.0130 | 1.0128 | 1.0126 | 1.0123 | 1.0158 | 1.0155 | 1.0152 | 1.0149 | 1.0147 | 1.0144 |
| 620 | 1.0138 | 1.0135 | 1.0132 | 1.0130 | 1.0128 | 1.0125 | 1.0161 | 1.0158 | 1.0155 | 1.0152 | 1.0149 | 1.0146 |
| 630 | 1.0140 | 1.0137 | 1.0135 | 1.0132 | 1.0130 | 1.0127 | 1.0164 | 1.0160 | 1.0157 | 1.0154 | 1.0152 | 1.0149 |
| 640 | 1.0142 | 1.0140 | 1.0137 | 1.0134 | 1.0132 | 1.0130 | 1.0166 | 1.0163 | 1.0160 | 1.0157 | 1.0154 | 1.0151 |
| 650 | 1.0144 | 1.0142 | 1.0139 | 1.0136 | 1.0134 | 1.0132 | 1.0169 | 1.0166 | 1.0163 | 1.0159 | 1.0156 | 1.0154 |
| 660 | 1.0147 | 1.0144 | 1.0141 | 1.0138 | 1.0136 | 1.0133 | 1.0171 | 1.0168 | 1.0165 | 1.0162 | 1.0159 | 1.0156 |
| 670 | 1.0149 | 1.0146 | 1.0143 | 1.0140 | 1.0138 | 1.0136 | 1.0174 | 1.0171 | 1.0168 | 1.0164 | 1.0161 | 1.0158 |
| 680 | 1.0151 | 1.0148 | 1.0145 | 1.0142 | 1.0140 | 1.0138 | 1.0177 | 1.0173 | 1.0170 | 1.0167 | 1.0164 | 1.0161 |
| 690 | 1.0154 | 1.0150 | 1.0148 | 1.0145 | 1.0142 | 1.0140 | 1.0179 | 1.0176 | 1.0173 | 1.0169 | 1.0166 | 1.0163 |
| 700 | 1.0156 | 1.0153 | 1.0150 | 1.0147 | 1.0144 | 1.0142 | 1.0182 | 1.0178 | 1.0175 | 1.0172 | 1.0169 | 1.0166 |
| 710 | 1.0158 | 1.0155 | 1.0152 | 1.0149 | 1.0146 | 1.0144 | 1.0185 | 1.0181 | 1.0178 | 1.0174 | 1.0171 | 1.0168 |
| 720 | 1.0160 | 1.0157 | 1.0154 | 1.0151 | 1.0148 | 1.0145 | 1.0188 | 1.0184 | 1.0180 | 1.0177 | 1.0174 | 1.0170 |
| 730 | 1.0163 | 1.0160 | 1.0157 | 1.0153 | 1.0150 | 1.0148 | 1.0190 | 1.0186 | 1.0183 | 1.0179 | 1.0176 | 1.0173 |
| 740 | 1.0165 | 1.0162 | 1.0159 | 1.0155 | 1.0153 | 1.0150 | 1.0193 | 1.0189 | 1.0185 | 1.0181 | 1.0178 | 1.0175 |
| 750 | 1.0167 | 1.0164 | 1.0161 | 1.0157 | 1.0155 | 1.0152 | 1.0195 | 1.0191 | 1.0188 | 1.0184 | 1.0180 | 1.0178 |
| 760 | 1.0169 | 1.0166 | 1.0163 | 1.0160 | 1.0157 | 1.0154 | 1.0198 | 1.0194 | 1.0190 | 1.0187 | 1.0183 | 1.0180 |
| 770 | 1.0171 | 1.0168 | 1.0165 | 1.0162 | 1.0159 | 1.0156 | 1.0200 | 1.0196 | 1.0193 | 1.0189 | 1.0186 | 1.0182 |
| 780 | 1.0174 | 1.0170 | 1.0167 | 1.0164 | 1.0161 | 1.0158 | 1.0203 | 1.0199 | 1.0195 | 1.0192 | 1.0188 | 1.0185 |
| 790 | 1.0176 | 1.0172 | 1.0169 | 1.0166 | 1.0163 | 1.0160 | 1.0206 | 1.0202 | 1.0198 | 1.0194 | 1.0190 | 1.0187 |
| 800 | 1.0178 | 1.0175 | 1.0171 | 1.0168 | 1.0165 | 1.0162 | 1.0208 | 1.0204 | 1.0200 | 1.0196 | 1.0193 | 1.0190 |
| 810 | 1.0180 | 1.0177 | 1.0174 | 1.0170 | 1.0167 | 1.0164 | 1.0211 | 1.0206 | 1.0203 | 1.0199 | 1.0195 | 1.0192 |
| 820 | 1.0183 | 1.0179 | 1.0176 | 1.0172 | 1.0169 | 1.0166 | 1.0213 | 1.0209 | 1.0205 | 1.0201 | 1.0198 | 1.0194 |
| 830 | 1.0185 | 1.0182 | 1.0178 | 1.0174 | 1.0171 | 1.0168 | 1.0216 | 1.0212 | 1.0208 | 1.0204 | 1.0200 | 1.0197 |
| 840 | 1.0188 | 1.0184 | 1.0180 | 1.0177 | 1.0174 | 1.0170 | 1.0219 | 1.0215 | 1.0210 | 1.0206 | 1.0203 | 1.0199 |
| 850 | 1.0190 | 1.0186 | 1.0182 | 1.0179 | 1.0176 | 1.0172 | 1.0221 | 1.0217 | 1.0213 | 1.0209 | 1.0205 | 1.0201 |
| 860 | 1.0192 | 1.0188 | 1.0184 | 1.0181 | 1.0177 | 1.0174 | 1.0224 | 1.0220 | 1.0215 | 1.0211 | 1.0208 | 1.0204 |
| 870 | 1.0194 | 1.0190 | 1.0187 | 1.0183 | 1.0180 | 1.0177 | 1.0227 | 1.0222 | 1.0218 | 1.0214 | 1.0210 | 1.0206 |
| 880 | 1.0196 | 1.0193 | 1.0189 | 1.0185 | 1.0182 | 1.0178 | 1.0229 | 1.0225 | 1.0220 | 1.0216 | 1.0212 | 1.0208 |
| 890 | 1.0198 | 1.0195 | 1.0191 | 1.0187 | 1.0184 | 1.0180 | 1.0232 | 1.0228 | 1.0223 | 1.0219 | 1.0215 | 1.0211 |
| 900 | 1.0201 | 1.0197 | 1.0193 | 1.0189 | 1.0186 | 1.0183 | 1.0235 | 1.0230 | 1.0225 | 1.0221 | 1.0217 | 1.0213 |
| 910 | 1.0203 | 1.0199 | 1.0195 | 1.0191 | 1.0188 | 1.0185 | 1.0237 | 1.0233 | 1.0228 | 1.0224 | 1.0220 | 1.0216 |
| 920 | 1.0205 | 1.0201 | 1.0197 | 1.0194 | 1.0190 | 1.0187 | 1.0240 | 1.0235 | 1.0231 | 1.0226 | 1.0222 | 1.0218 |
| 930 | 1.0208 | 1.0204 | 1.0200 | 1.0196 | 1.0192 | 1.0189 | 1.0242 | 1.0238 | 1.0233 | 1.0229 | 1.0225 | 1.0220 |
| 940 | 1.0210 | 1.0206 | 1.0202 | 1.0198 | 1.0194 | 1.0191 | 1.0245 | 1.0240 | 1.0235 | 1.0231 | 1.0227 | 1.0223 |
| 950 | 1.0212 | 1.0208 | 1.0204 | 1.0200 | 1.0196 | 1.0193 | 1.0248 | 1.0243 | 1.0238 | 1.0233 | 1.0229 | 1.0225 |
| 960 | 1.0214 | 1.0210 | 1.0206 | 1.0202 | 1.0198 | 1.0195 | 1.0250 | 1.0246 | 1.0241 | 1.0236 | 1.0232 | 1.0228 |
| 970 | 1.0216 | 1.0212 | 1.0208 | 1.0204 | 1.0200 | 1.0197 | 1.0253 | 1.0248 | 1.0243 | 1.0238 | 1.0234 | 1.0230 |
| 980 | 1.0219 | 1.0215 | 1.0210 | 1.0206 | 1.0203 | 1.0199 | 1.0256 | 1.0251 | 1.0246 | 1.0241 | 1.0237 | 1.0232 |
| 990 | 1.0221 | 1.0217 | 1.0212 | 1.0208 | 1.0205 | 1.0201 | 1.0258 | 1.0253 | 1.0248 | 1.0243 | 1.0239 | 1.0235 |

In sonic measurements of fluid levels to determine subsurface working pressures, it is necessary to include the pressure exerted by the weight of the gas column.

To use multipliers, select correct figure (based on the correct values of L, G, and temperature) and multiply the absolute pressure on the casinghead by selected figure to obtain absolute pressure at the base of the static gas column, i.e., the oil-gas contact.

Example: Casing pressure on a pumping well is 286.6 lb. per sq. in. abs. Gravity and temperature of the gas are 0.70 and 70°F., respectively. Depth to fluid level is 970 ft. What is pressure at fluid level in well?

Solution: From table, multiplier is 1.0243
286.6 × 1.0243 = 293.6 lb. per sq. in. abs. = pressure at fluid level.
In other words, weight of gas column is 7.0 lb. per sq. in.

Note: Multipliers are calculated from following formula[1]:

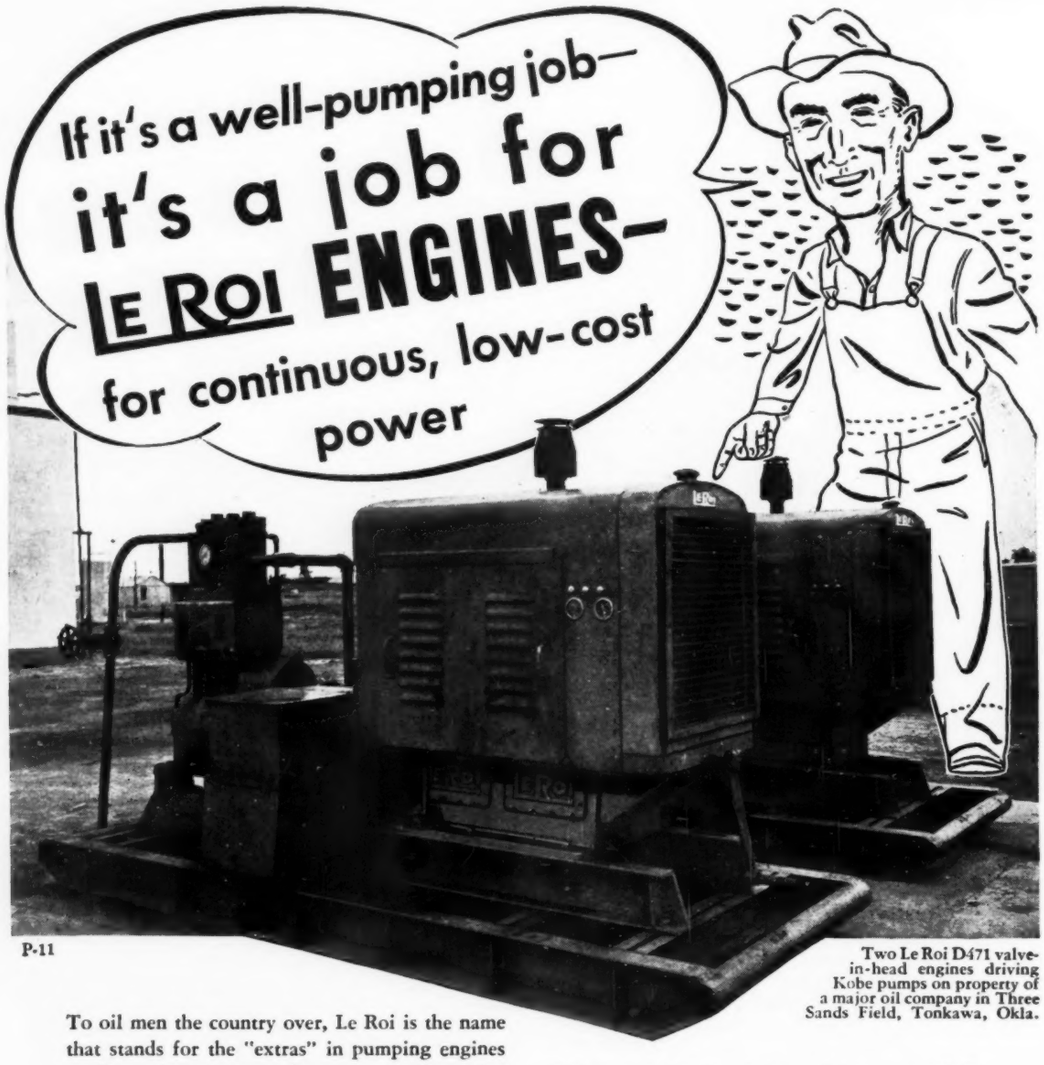
$$\text{multiplier} = (GL \div 53.34T) \log e$$

where G = specific gravity of gas (air = 1.00)
53.34 = constant for air
L = length of gas column, ft.
T = absolute temperature of gas, °F.
log $e$ = log to base 10 of Naperian log base = 0.4342945

[1]See page 162 of Monograph 7, U. S. Bureau of Mines.

*Table suggested by W. F. Eiting, Jr., Carter Oil Company, St. Elmo, Illinois.*

# If it's a well-pumping job— it's a job for LE ROI ENGINES— for continuous, low-cost power



P-11

Two Le Roi D471 valve-in-head engines driving Kobe pumps on property of a major oil company in Three Sands Field, Tonkawa, Okla.

To oil men the country over, Le Roi is the name that stands for the "extras" in pumping engines **— the *extra* reserve of power . . . the *extra* margin of economy and the *extra* accessories that improve performance and safeguard the engine.** Model D471 (illustrated) is typical of what's behind that reputation. • Here's a two-fisted engine *specially designed* and built to take the hard knocks on *your kind of job,* operating 24 hours — day in and day out! *Valve-in-head* construction assures quick accessibility, fuel economy, lower operating costs. *Hardened valve seat inserts* minimize frequency of valve grinding and adjustments. *Removable wet sleeve cylinders* can be easily and inexpensively replaced. *Favorable torque characteristics* and heavy, carefully proportioned flywheels assure smooth operation under peak loads. These and many other features uphold your good judgment in insisting on Le Roi. • Le Roi also offers other models in a complete range of sizes from 3 to 115 H.P. — all economical to operate with natural gas, gasoline, or butane . . . all fully enclosed for protection against tampering or bad weather. • Write for Bulletins PA, PE3 and PE176 . . . study Le Roi's features . . . then equip with Le Roi on your next job.

**LE ROI COMPANY** • MILWAUKEE, WIS. • TULSA, OKLA.
Southern Engine & Pump Company, Houston—Dallas—Kilgore, Texas
General Machine & Supply Company, Wichita Falls—Odessa, Texas
Western Machinery Company, St. Louis, Missouri • Centralia, Illinois

Static Press.
3000-3095 lb.

# PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

| Differential pressure, in. of water | Static pressure, lb. per sq. in. ga. | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3000 | 3005 | 3010 | 3015 | 3020 | 3025 | 3030 | 3035 | 3040 | 3045 | 3050 | 3055 | 3060 | 3065 | 3070 | 3075 | 3080 | 3085 | 3090 | 3095 |
| 2 | 77.64 | 77.70 | 77.77 | 77.83 | 77.90 | 77.95 | 78.02 | 78.09 | 78.15 | 78.22 | 78.28 | 78.35 | 78.41 | 78.48 | 78.53 | 78.60 | 78.66 | 78.73 | 78.79 | 78.86 |
| 4 | 109.8 | 109.9 | 110.0 | 110.1 | 110.2 | 110.3 | 110.4 | 110.5 | 110.5 | 110.6 | 110.7 | 110.8 | 110.9 | 111.0 | 111.1 | 111.2 | 111.3 | 111.4 | 111.5 | 111.6 |
| 6 | 134.5 | 134.6 | 134.7 | 134.8 | 134.9 | 135.0 | 135.1 | 135.3 | 135.4 | 135.5 | 235.6 | 135.7 | 135.8 | 135.9 | 136.0 | 136.1 | 136.2 | 136.4 | 136.5 | 136.6 |
| 8 | 155.3 | 155.4 | 155.5 | 155.7 | 155.8 | 155.9 | 156.0 | 156.2 | 156.3 | 156.4 | 156.6 | 156.7 | 156.8 | 156.9 | 157.1 | 157.2 | 157.3 | 157.5 | 157.6 | 157.8 |
| 10 | 173.6 | 173.8 | 173.9 | 174.0 | 174.2 | 174.3 | 174.5 | 174.6 | 174.8 | 174.9 | 175.0 | 175.2 | 175.3 | 175.5 | 175.6 | 175.8 | 175.9 | 186.1 | 176.2 | 176.3 |
| 12 | 190.2 | 190.3 | 190.5 | 190.7 | 190.8 | 190.9 | 191.1 | 191.3 | 191.5 | 191.6 | 191.8 | 191.9 | 192.1 | 192.3 | 192.4 | 192.6 | 192.7 | 192.9 | 193.0 | 193.2 |
| 14 | 205.5 | 205.6 | 205.8 | 205.9 | 206.1 | 206.3 | 206.5 | 206.7 | 206.8 | 207.0 | 207.0 | 207.3 | 207.5 | 207.7 | 207.8 | 208.0 | 208.2 | 208.4 | 208.5 | 208.7 |
| 16 | 219.6 | 219.8 | 220.0 | 220.2 | 220.4 | 220.5 | 220.7 | 220.9 | 221.1 | 221.3 | 221.4 | 221.6 | 221.8 | 222.0 | 222.2 | 222.4 | 222.5 | 222.7 | 222.9 | 223.1 |
| 18 | 232.9 | 233.2 | 233.4 | 233.5 | 233.7 | 233.9 | 234.1 | 234.3 | 234.5 | 234.7 | 234.9 | 235.1 | 235.3 | 235.5 | 235.7 | 235.9 | 236.0 | 236.3 | 236.4 | 236.6 |
| 20 | 245.6 | 245.7 | 245.9 | 246.1 | 246.4 | 246.5 | 246.8 | 246.9 | 247.2 | 247.4 | 247.6 | 247.8 | 247.9 | 248.2 | 248.4 | 248.6 | 248.8 | 249.0 | 249.2 | 249.4 |
| 21 | 251.7 | 251.8 | 252.1 | 252.2 | 252.5 | 252.7 | 252.9 | 253.1 | 253.3 | 253.5 | 253.7 | 253.9 | 254.1 | 254.4 | 254.5 | 254.8 | 254.9 | 255.2 | 255.4 | 255.6 |
| 22 | 257.5 | 257.7 | 257.9 | 258.1 | 258.4 | 258.6 | 258.8 | 259.0 | 259.2 | 259.5 | 259.6 | 259.9 | 260.1 | 260.3 | 260.5 | 260.7 | 260.9 | 261.1 | 261.3 | 261.6 |
| 23 | 263.3 | 263.5 | 263.8 | 263.9 | 264.2 | 264.4 | 264.6 | 264.9 | 265.1 | 265.3 | 265.5 | 265.7 | 265.9 | 266.2 | 266.4 | 266.6 | 266.8 | 267.0 | 267.2 | 267.5 |
| 24 | 269.0 | 269.2 | 269.4 | 269.6 | 269.9 | 270.1 | 270.3 | 270.6 | 260.8 | 271.0 | 271.2 | 271.5 | 271.6 | 261.9 | 272.1 | 272.3 | 272.5 | 272.8 | 262.9 | 273.2 |
| 25 | 274.6 | 274.8 | 275.0 | 275.2 | 275.5 | 275.7 | 275.9 | 276.2 | 276.4 | 276.6 | 276.8 | 277.1 | 277.3 | 277.5 | 277.7 | 277.9 | 278.2 | 278.4 | 278.6 | 278.9 |
| 26 | 279.9 | 280.2 | 280.4 | 280.6 | 280.9 | 281.1 | 281.4 | 281.6 | 281.8 | 282.1 | 282.3 | 282.5 | 282.7 | 282.9 | 283.2 | 283.5 | 283.7 | 283.9 | 284.1 | 284.4 |
| 27 | 285.3 | 285.5 | 285.8 | 285.9 | 286.2 | 286.5 | 286.7 | 286.9 | 287.2 | 287.4 | 287.7 | 287.9 | 288.1 | 288.4 | 288.6 | 288.8 | 289.1 | 289.3 | 289.5 | 289.8 |
| 28 | 290.6 | 290.8 | 291.1 | 291.3 | 291.5 | 291.7 | 292.0 | 292.3 | 292.5 | 292.8 | 292.9 | 293.2 | 293.4 | 293.7 | 293.9 | 294.2 | 294.4 | 294.7 | 294.9 | 295.1 |
| 29 | 295.7 | 295.9 | 296.2 | 296.4 | 296.7 | 296.9 | 297.1 | 297.4 | 297.6 | 297.9 | 298.1 | 298.4 | 298.6 | 298.9 | 299.1 | 299.4 | 299.6 | 299.8 | 300.1 | 300.3 |
| 30 | 300.7 | 300.9 | 301.2 | 301.5 | 301.7 | 301.9 | 302.2 | 302.5 | 302.7 | 302.9 | 303.2 | 303.5 | 303.7 | 303.9 | 304.2 | 304.5 | 204.7 | 304.9 | 305.2 | 305.5 |
| 31 | 305.7 | 305.9 | 306.2 | 306.5 | 306.7 | 306.9 | 307.2 | 307.5 | 307.7 | 308.0 | 308.2 | 308.5 | 308.7 | 309.0 | 309.2 | 309.5 | 309.7 | 310.0 | 310.3 | 310.5 |
| 32 | 310.6 | 310.9 | 311.1 | 311.4 | 311.6 | 311.9 | 312.2 | 312.4 | 312.7 | 312.9 | 313.2 | 313.5 | 313.7 | 313.9 | 314.2 | 314.5 | 314.7 | 314.9 | 315.2 | 315.5 |
| 33 | 315.5 | 315.7 | 315.9 | 316.2 | 316.5 | 316.7 | 317.0 | 317.3 | 317.5 | 317.8 | 318.0 | 318.3 | 318.6 | 318.8 | 319.1 | 319.4 | 319.6 | 319.9 | 320.1 | 320.4 |
| 34 | 320.2 | 320.4 | 320.7 | 320.9 | 321.2 | 321.5 | 321.8 | 322.0 | 322.3 | 322.6 | 322.8 | 323.1 | 323.3 | 323.6 | 323.9 | 324.1 | 324.4 | 324.7 | 324.9 | 325.2 |
| 35 | 324.8 | 325.1 | 325.4 | 325.6 | 325.9 | 326.1 | 326.4 | 326.7 | 326.9 | 327.3 | 327.5 | 327.8 | 328.0 | 328.3 | 328.6 | 328.9 | 329.1 | 329.4 | 329.6 | 329.9 |
| 36 | 329.5 | 329.7 | 330.0 | 330.2 | 330.5 | 330.8 | 331.1 | 331.4 | 331.6 | 331.9 | 332.2 | 332.5 | 332.7 | 333.0 | 333.2 | 333.5 | 333.8 | 334.1 | 334.3 | 334.6 |
| 37 | 334.0 | 334.3 | 334.6 | 334.8 | 335.1 | 335.4 | 335.7 | 335.9 | 336.2 | 336.5 | 336.8 | 337.1 | 337.3 | 337.6 | 337.8 | 338.2 | 338.4 | 338.7 | 338.9 | 339.2 |
| 38 | 338.5 | 338.7 | 339.0 | 339.3 | 339.6 | 339.8 | 340.1 | 340.4 | 340.7 | 340.9 | 341.2 | 341.5 | 341.8 | 342.1 | 342.3 | 342.7 | 342.9 | 343.2 | 343.5 | 343.8 |
| 39 | 342.9 | 343.2 | 343.5 | 343.7 | 344.0 | 344.3 | 344.6 | 344.9 | 345.2 | 345.5 | 345.7 | 346.0 | 346.3 | 346.6 | 346.8 | 347.2 | 347.4 | 347.7 | 347.9 | 348.3 |
| 40 | 347.3 | 347.6 | 347.9 | 348.1 | 348.4 | 348.7 | 349.0 | 349.3 | 349.6 | 349.9 | 350.2 | 350.5 | 350.7 | 351.0 | 351.3 | 351.6 | 351.9 | 352.2 | 352.4 | 352.7 |
| 41 | 351.6 | 351.8 | 352.2 | 352.4 | 352.7 | 352.9 | 353.3 | 353.6 | 353.9 | 354.2 | 354.5 | 354.8 | 355.0 | 355.4 | 355.6 | 355.9 | 356.2 | 356.5 | 356.8 | 357.1 |
| 42 | 355.9 | 356.1 | 356.5 | 356.7 | 357.0 | 357.3 | 357.6 | 357.9 | 358.2 | 358.5 | 358.8 | 359.1 | 359.4 | 359.7 | 359.9 | 360.3 | 360.5 | 360.9 | 361.1 | 361.4 |
| 43 | 360.0 | 360.3 | 360.6 | 360.9 | 361.2 | 361.5 | 361 8 | 362.1 | 362.4 | 362.7 | 362.9 | 363.3 | 363.6 | 363.9 | 364.2 | 364.5 | 364.8 | 365.1 | 365.4 | 365.7 |
| 44 | 364.2 | 364.5 | 364.8 | 365.1 | 365.4 | 365.7 | 366.0 | 366.3 | 366.6 | 366.9 | 367.2 | 367.5 | 367.8 | 368.1 | 368.4 | 368.7 | 368.9 | 369.3 | 369.6 | 369.9 |
| 45 | 368.3 | 368.6 | 368.9 | 369.2 | 369.5 | 369.8 | 370.1 | 370.5 | 370.8 | 371.1 | 371.4 | 371.7 | 371.9 | 372.3 | 372.6 | 372.9 | 373.2 | 373.5 | 373.8 | 374.1 |
| 46 | 372.4 | 372.7 | 373.0 | 373.3 | 373.6 | 373.9 | 374.2 | 374.6 | 374.8 | 375.2 | 375.5 | 375.8 | 376.1 | 376.4 | 376.7 | 377.0 | 377.3 | 377.6 | 377.9 | 378.2 |
| 47 | 376.5 | 376.7 | 377.1 | 377.4 | 377.7 | 377.9 | 378.3 | 378.7 | 378.9 | 379.3 | 379.5 | 379.9 | 380.2 | 380.5 | 380.8 | 381.1 | 381.4 | 381.7 | 382.0 | 382.4 |
| 48 | 380.4 | 380.7 | 381.0 | 381.3 | 381.7 | 381.9 | 382.3 | 382.6 | 382.9 | 383.3 | 383.5 | 383.9 | 384.2 | 384.5 | 384.8 | 385.1 | 385.4 | 385.8 | 386.0 | 386.4 |
| 49 | 384.4 | 384.7 | 385.0 | 385.3 | 385.6 | 385.9 | 386.3 | 386.6 | 386.9 | 387.2 | 387.5 | 387.9 | 388.2 | 388.5 | 388.8 | 389.1 | 389.4 | 389.8 | 390.0 | 390.4 |
| 50 | 388.3 | 388.6 | 388.9 | 389.2 | 389.5 | 389.8 | 390.2 | 390.5 | 390.8 | 391.2 | 391.5 | 391.8 | 382.1 | 392.4 | 392.7 | 393.1 | 393.4 | 393.7 | 393.9 | 394.3 |
| 51 | 392.1 | 392.4 | 392.8 | 393.0 | 393.4 | 393.7 | 394.0 | 394.4 | 394.7 | 395.0 | 395.3 | 395.7 | 395.9 | 396.3 | 396.6 | 396.9 | 397.3 | 397.6 | 397.9 | 398.3 |
| 52 | 395.9 | 396.2 | 396.6 | 396.9 | 397.3 | 397.5 | 397.9 | 398.3 | 398.6 | 398.9 | 399.2 | 399.6 | 399.8 | 400.2 | 400.5 | 400.9 | 401.1 | 401.5 | 401.8 | 402.2 |
| 53 | 399.7 | 400.0 | 400.4 | 400.7 | 401.1 | 401.3 | 401.7 | 402.1 | 402.4 | 402.7 | 403.0 | 403.4 | 403.7 | 404.0 | 404.3 | 404.7 | 404.9 | 405.4 | 405.6 | 406.0 |
| 54 | 403.5 | 403.8 | 404.1 | 404.4 | 404.8 | 405.1 | 405.5 | 405.8 | 406.1 | 406.5 | 406.8 | 40.2 | 40.4 | 407.8 | 408.1 | 408.5 | 408.8 | 409.1 | 409.1 | 409.8 |
| 55 | 407.2 | 407.5 | 407.9 | 408.2 | 408.5 | 408.8 | 409.2 | 409.6 | 409.9 | 410.3 | 410.5 | 410.9 | 411.2 | 411.6 | 411.9 | 412.3 | 412.6 | 412.9 | 413.2 | 413.6 |
| 56 | 410.9 | 411.2 | 411.6 | 411.9 | 412.2 | 412.5 | 412.9 | 413.3 | 413.6 | 413.9 | 414.3 | 414.6 | 414.9 | 415.3 | 415.6 | 415.9 | 416.3 | 416.7 | 416.9 | 417.3 |
| 57 | 414.6 | 414.9 | 415.3 | 415.6 | 415.9 | 416.2 | 416.6 | 416.9 | 417.3 | 417.7 | 417.9 | 418.3 | 418.6 | 419.0 | 419.3 | 419.7 | 420.0 | 420.4 | 420.7 | 421.1 |
| 58 | 418.2 | 418.5 | 418.9 | 419.2 | 419.6 | 419.8 | 120.3 | 420.6 | 420.9 | 421.3 | 421.6 | 422.0 | 422.3 | 422.7 | 422.9 | 423.4 | 423.7 | 424.1 | 424.4 | 424.7 |
| 59 | 421.8 | 422.1 | 422.5 | 422.8 | 423.1 | 423.5 | 123.8 | 424.2 | 424.5 | 424.9 | 425.2 | 425.6 | 425.9 | 426.3 | 426.6 | 426.9 | 427.3 | 427.7 | 427.9 | 428.4 |
| 60 | 425.3 | 425.6 | 426.0 | 426.3 | 426.7 | 427.0 | 427.4 | 427.8 | 128.1 | 428.5 | 428.8 | 429.2 | 429.5 | 429.9 | 430.2 | 430.6 | 420.9 | 431.3 | 431.6 | 431.9 |
| 61 | 428.8 | 429.2 | 429.6 | 429.9 | 430.3 | 430.6 | 430.9 | 431.3 | 431.7 | 432.0 | 432.4 | 432.8 | 433.1 | 433.5 | 433.8 | 434.2 | 434.5 | 434.9 | 435.2 | 435.6 |
| 62 | 423.4 | 432.7 | 433.1 | 433.4 | 433.8 | 434.1 | 434.5 | 434.9 | 435.2 | 435.6 | 435.9 | 436.3 | 436.6 | 437.0 | 437.3 | 437.7 | 438.0 | 438.4 | 438.7 | 439.1 |
| 63 | 435.8 | 436.1 | 436.5 | 436.9 | 437.2 | 437.6 | 437.9 | 438.4 | 438.7 | 439.1 | 439.4 | 439.8 | 440.1 | 440.5 | 440.8 | 441.2 | 441.5 | 441.9 | 442.2 | 442.6 |
| 64 | 439.3 | 439.6 | 440.0 | 440.3 | 440.7 | 441.0 | 441.4 | 441.8 | 442.2 | 442.6 | 442.9 | 443.3 | 443.6 | 444.0 | 444.3 | 444.7 | 445.0 | 445.4 | 445.8 | 446.2 |
| 65 | 442.7 | 443.0 | 443.4 | 443.7 | 444.1 | 444.5 | 444.9 | 445.3 | 445.6 | 145.9 | 446.3 | 446.7 | 447.0 | 447.4 | 447.8 | 448.2 | 448.5 | 448.9 | 449.2 | 449.6 |
| 66 | 446.1 | 446.4 | 446.8 | 447.1 | 447.6 | 447.9 | 448.3 | 448.7 | 449.0 | 449.4 | 449.7 | 450.2 | 450.5 | 450.9 | 451.2 | 451.6 | 451.9 | 452.3 | 452.7 | 453.1 |
| 67 | 449.4 | 449.8 | 450.2 | 450.5 | 450.9 | 451.2 | 451.6 | 452.1 | 452.4 | 452.8 | 453.1 | 453.5 | 453.9 | 454.3 | 454.6 | 455.0 | 455.3 | 455.7 | 456.1 | 456.5 |
| 68 | 452.8 | 453.1 | 453.5 | 453.9 | 454.3 | 454.6 | 455.0 | 455.4 | 455.8 | 456.2 | 456.5 | 456.9 | 457.2 | 457.7 | 457.9 | 458.4 | 458.7 | 459.1 | 459.5 | 459.9 |
| 69 | 456.1 | 456.5 | 456.9 | 457.2 | 457.6 | 457.9 | 458.4 | 458.8 | 459.1 | 459.5 | 459.9 | 460.3 | 460.6 | 461.0 | 461.4 | 461.8 | 462.1 | 462.5 | 462.9 | 463.3 |
| 70 | 459.4 | 459.8 | 460.2 | 460.5 | 460.9 | 461.3 | 461.7 | 462.1 | 462.4 | 462.9 | 463.2 | 463.6 | 463.9 | 464.4 | 464.7 | 465.1 | 465.5 | 465.9 | 466.2 | 466.6 |
| 71 | 462.7 | 463.0 | 463.4 | 463.8 | 464.2 | 464.5 | 464.9 | 465.4 | 465.7 | 466.1 | 466.5 | 466.9 | 467.2 | 467.6 | 467.9 | 468.4 | 468.7 | 469.2 | 469.5 | 469.9 |
| 72 | 465.9 | 466.3 | 466.7 | 467.0 | 467.4 | 467.8 | 468.2 | 468.6 | 468.9 | 469.4 | 469.7 | 470.2 | 470.5 | 470.9 | 471.3 | 471.7 | 472.0 | 472.4 | 472.8 | 473.2 |
| 73 | 469.2 | 469.5 | 469.9 | 470.3 | 470.7 | 471.0 | 471.5 | 471.9 | 472.2 | 472.7 | 472.9 | 473.4 | 473.8 | 174.2 | 474.5 | 474.9 | 475.3 | 475.7 | 476.1 | 476.5 |
| 74 | 472.3 | 472.7 | 473.1 | 473.5 | 473.9 | 474.2 | 174 7 | 475.1 | 475.4 | 475.9 | 476.2 | 476.6 | 476.9 | 477.4 | 477.8 | 478.2 | 478.5 | 478.9 | 479.3 | 479.7 |
| 75 | 475.5 | 475.9 | 476.3 | 476.6 | 477.1 | 477.4 | 477.9 | 478.3 | 478.6 | 479.1 | 479.4 | 479.9 | 480.2 | 480.6 | 480.9 | 481.4 | 481.8 | 482.2 | 482.5 | 482.9 |
| 76 | 478.7 | 479.1 | 479.5 | 479.8 | 480.3 | 480.6 | 481.1 | 481 5 | 481.8 | 482.3 | 482.6 | 483.1 | 483.4 | 483.8 | 484.2 | 484.6 | 484.9 | 485.4 | 485.8 | 486.2 |
| 77 | 481.8 | 482.2 | 482.6 | 482.9 | 483.4 | 483.8 | 484.2 | 484.6 | 484.9 | 485.4 | 485.8 | 486.2 | 486.6 | 487.0 | 487.4 | 487.8 | 488.2 | 488.6 | 488.9 | 489.4 |
| 78 | 484.9 | 485.3 | 485.8 | 486.1 | 486.6 | 486.9 | 487.3 | 487.8 | 488.1 | 188.6 | 488.9 | 489.4 | 489.7 | 490.2 | 490.5 | 490.9 | 491.3 | 491.8 | 492.1 | 492.6 |
| 79 | 488.0 | 488.4 | 488.8 | 489.2 | 489.6 | 489.9 | 490.4 | 490.9 | 491.2 | 491.7 | 492.0 | 492.5 | 492.8 | 493.3 | 493.6 | 494.1 | 494.4 | 494.9 | 495.2 | 495.7 |
| 80 | 491.1 | 491.5 | 491.9 | 492.3 | 492.7 | 493.1 | 493.5 | 493.9 | 494.3 | 494.8 | 495.1 | 495.6 | 495.9 | 496.4 | 496.7 | 497.2 | 497.6 | 498.0 | 498.4 | 498.8 |
| 82 | 497.2 | 497.6 | 498.0 | 498.4 | 498.8 | 499.2 | 499.7 | 500.1 | 500.5 | 500.9 | 501.3 | 501.7 | 502.1 | 502.6 | 502.9 | 503.4 | 503.7 | 504.4 | 504.5 | 504.9 |
| 84 | 503.3 | 503.6 | 504.1 | 504.4 | 504.9 | 505.3 | 505.7 | 506.2 | 506.5 | 507.0 | 507.4 | 507.8 | 508.2 | 508.7 | 509.0 | 509.5 | 509.8 | 510.3 | 510.7 | 511.1 |
| 86 | 509.2 | 509.6 | 510.1 | 510.4 | 510.9 | 511.3 | 511.7 | 512.2 | 512.6 | 513.0 | 513.4 | 513.9 | 514.2 | 514.7 | 515.1 | 515.5 | 515.9 | 516.4 | 516.7 | 517.2 |
| 88 | 515.1 | 515.1 | 515.9 | 516.3 | 516.8 | 517.2 | 517.6 | 518.1 | 518.5 | 518.5 | 519.3 | 519.8 | 520.2 | 520.6 | 521.0 | 521.5 | 521.9 | 522.3 | 522.7 | 523.2 |
| 90 | 520.9 | 521.3 | 521.8 | 522.2 | 522.6 | 523.0 | 523.5 | 523.9 | 524.3 | 524.8 | 525.2 | 525.7 | 526.1 | 526.5 | 526.9 | 527.4 | 527.8 | 528.2 | 528.6 | 529.1 |
| 92 | 526.7 | 527.1 | 527.6 | 527.9 | 528.4 | 528.8 | 529.3 | 529.8 | 530.1 | 530.6 | 531.0 | 531.5 | 531.9 | 532.4 | 532.7 | 533.2 | 533.6 | 534.1 | 534.5 | 534.9 |
| 94 | 532.4 | 532.7 | 533.2 | 533.6 | 534.1 | 534.5 | 534.9 | 535.5 | 535.8 | 536.3 | 536.7 | 537.2 | 537.6 | 538.1 | 538.5 | 538.9 | 539.3 | 539.8 | 540.2 | 540.7 |
| 96 | 538.0 | 538.4 | 538.9 | 539.3 | 539.8 | 540.2 | 540.7 | 541.1 | 541.5 | 542.0 | 542.4 | 542.9 | 543.3 | 543.8 | 544.2 | 544.7 | 545.1 | 545.6 | 545.9 | 546.4 |
| 98 | 543.6 | 543.9 | 544.4 | 544.8 | 545.3 | 545.7 | 546.2 | 546.7 | 547.1 | 547.6 | 548.0 | 548.3 | 548.9 | 549.4 | 549.8 | 550.3 | 550.7 | 551.2 | 551.6 | 552.1 |
| 100 | 549.1 | 549.5 | 550.0 | 550.4 | 550.9 | 551.3 | 551.8 | 552.3 | 552.7 | 553.2 | 553.6 | 554.1 | 554.5 | 555.0 | 555.4 | 555.9 | 556.3 | 556.8 | 557.2 | 557.7 |

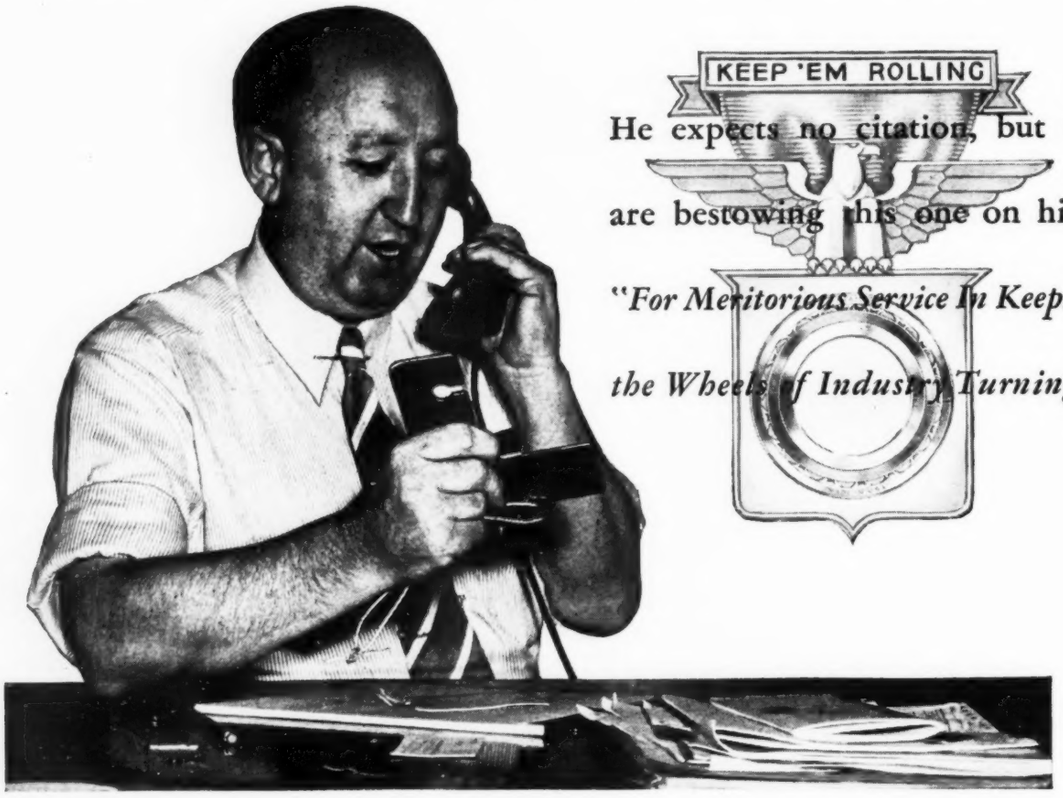
NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water, respectively.

Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

## HYATT SALUTES THE MAINTENANCE MAN—

# HERO in the BATTLE of PRODUCTION






He expects no citation, but we are bestowing this one on him:

*"For Meritorious Service In Keeping the Wheels of Industry Turning."*

HIS IS A VITAL JOB. He may be Master Mechanic, Maintenance Superintendent, Chief Engineer, Plant Engineer, Millwright Foreman or carry no particular title at all. But he's a mighty important factor in America's all-out war effort.

He doesn't design the guns, ships, planes, tanks, trucks, etc.; neither is he accredited with their "beat the production" schedules. But when machines of war roll off the assembly lines, he's the fellow behind the scenes who keeps them rolling.

He's one of the unsung heroes of this battle of production. He symbolizes a whole army of quiet, determined men who are driving home the terrific power of American efficiency with cool but furious intensity.

We know him well... industry's man of war. We've worked with him in less troubled times and we meet him regularly now in our job of supplying bearings for America's hard-hitting planes, guns, tanks, ships, and trucks; and for the steel-sinewed machine tools, cranes, motors, and so on with which they are produced.

It's he who keeps the wheels of industry turning... he whom we salute... he of the production line that backs up the boys on the firing line.

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

## THE 50TH YEAR OF HYATT ROLLER BEARINGS

# Solvent-Treating Method Releases Tight Pipe-Line Valve Stems

PETROLEUM ENGINEER Exclusive Feature

☆ Obviates need for removing valve from line for dis-assembly and cleaning

*by George J. Hill*

Supervisor of Regulators, Consumers Gas Company, Toronto, Canada

THE present emergency has required unprecedented care of all equipment to maintain operation for the duration of the war. Equipment is now carefully checked for possible reclamation and repair before being relegated to the scrap drive. Equipment in operation receives periodic inspection in an effort to avoid unnecessary deterioration.

Valves on bypass lines and on other lines and equipment that are infrequently used often freeze or become tight causing the operator to lose operating time; often damaging the valve stem threads, as well as the valve itself in forcing valve closing or opening by means of a "cheater." Yet additional time and expense are forfeited if it is required that the valve be taken from the line for dis-assembly and complete cleaning.

The following method of releasing tight valve stems has been used by The Consumers Gas Company of Toronto, Canada, and has proved successful in all cases for frozen or tight valves of the type herein described.

## Treating Low-Pressure Valves

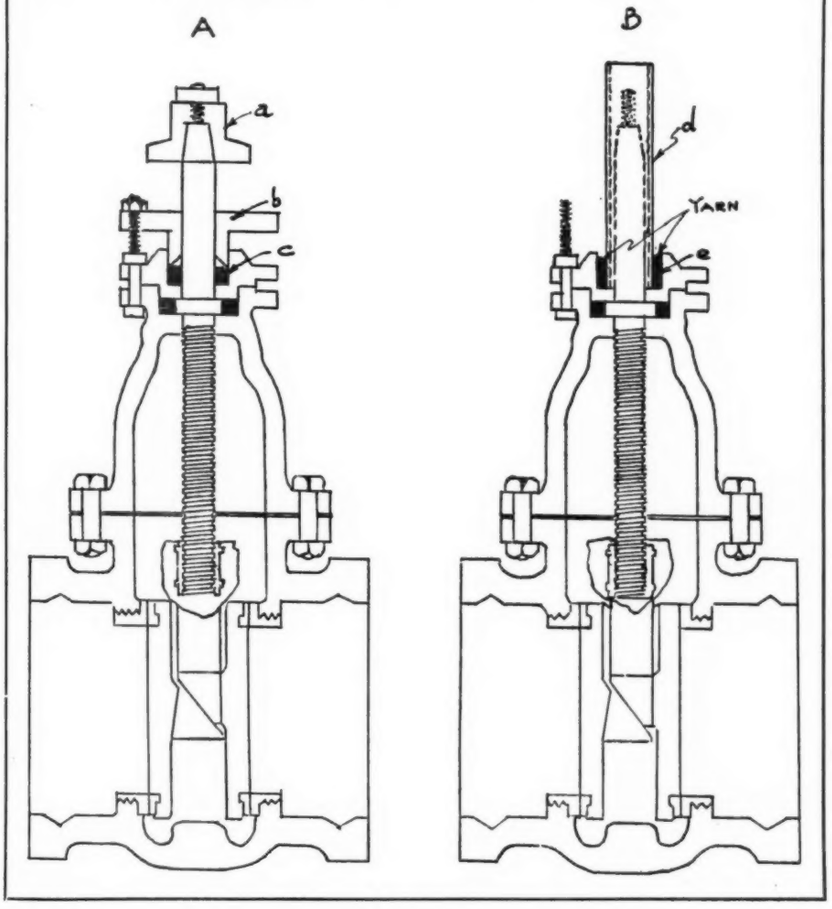
Adaptation of the method to low-pressure valves is indicated in Fig. 1-A. All visible dirt and foreign matter are cleaned from the stuffing box after the adapter "a" is removed from the spindle and the packing gland "b" and packing "c" are removed.

As shown in Fig. 1-B a piece of 2-in. steel pipe "d" is slipped over the stem or spindle and caulked at "e" into the stuffing box with graphite or yarn packing.

The 2-in. pipe then acts as a container for about one-half pint of penetrating oil with the remaining space filled with tetralin, $C_{10}H_{12}$. Some idea of the extent to which the valve is frozen may be had by observing the rate of diminishment of the liquid in the pipe. It has been found that some valves are freed in 15 minutes whereas others require as much time as 20 hours.

Treatment of a particularly tight valve can be spread over a number of days with periods of treatment lasting

*Fig. 1. Adaptation of method to low-pressure valves*



**GEORGE J. HILL**

was born in Toronto, Canada, 49 years ago—Educated in the Toronto public schools, he attended Toronto Technical School, and later took an extension course in gas distribution, transmission, and utilization from the University of New Brunswick (New Jersey)—Has been affiliated with the gas industry 30 years—Began as a fitter's helper and gained practical knowledge in many branches of the gas industry, including appliances, pipe fitting, maintenance, meters, pressure work, testing, etc.—In 1926 was made supervisor of high-pressure regulators and valves by the Consumers Gas Company—Is the inventor of a new type pump for blocking gas mains in case of air raids—Also has invented apparatus for gas purification, and a gas leak detector for locating gas leaks in subsurface gas mains.

several hours each day. It has been found that only a negligible volume of gas escapes during the treating period. Patience and care must be exercised for successful use of the method.

### High-Pressure Valves

The method differs somewhat for use on valves in medium high-pressure lines. Fig. 2 shows the set-up for this operation. The adapter, packing gland, and packing are removed as was done with the low-pressure valve, however, a stop cock "g" is inserted in the 2-in. pipe with a small bypass line "h" connected as shown in the sketch to equalize the pressure in the valve and in the 2-in. pipe. A bracket is supplied to assist in holding the 2-in. pipe in place and is bolted to the valve. After the 2-in. pipe is filled as previously done in the low-pressure valve, the bypass line valve is slowly opened to equalize the pressures and finally the 2-in. valve is opened permitting the liquid to reach the valve. Usually, it is necessary to wear gas masks when performing the operation on high-pressure valves.

### Adaptability of Method

Valves ranging in size from 8 to 24 in. have been freed by this method. Some valves freed by the method could not be turned by the standard key even with pipe extensions operated by several men.

It has been found that the foreign matter causing the freezing trouble, or seizure, of the valves is deposited in the grooves between the threads of the stem or spindle of the valve. The method herein described, although used only on gas lines, should be easily adaptable to liquefied petroleum gases, as well as to natural gas.

☆ ☆ ☆

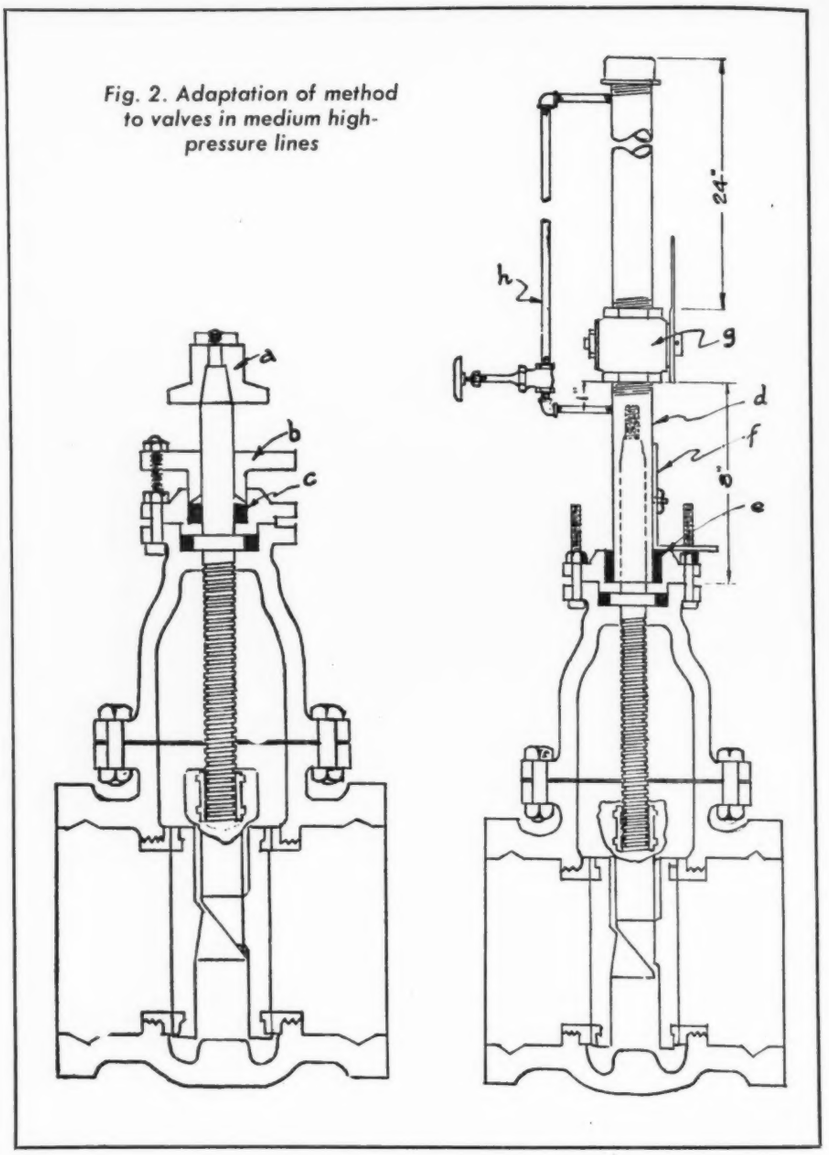



*Fig. 2. Adaptation of method to valves in medium high-pressure lines*

P 835.

# Lubricating High Temperature Oil Machinery Bearings

*by*

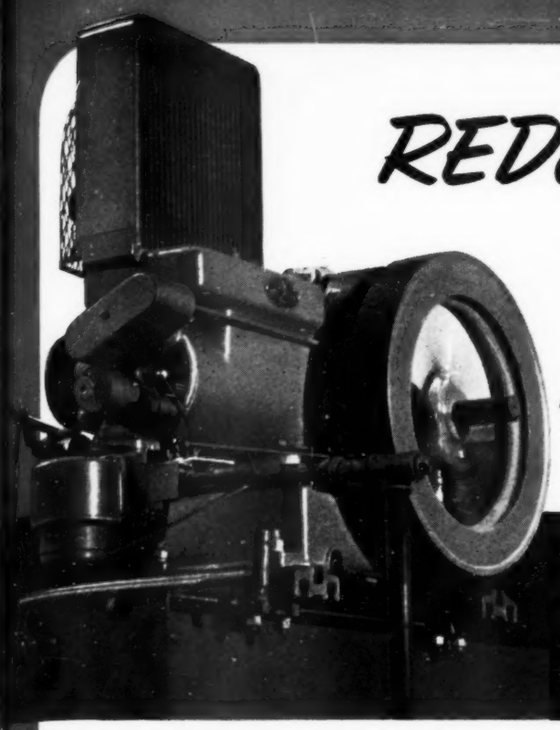
*W. F. Schaphorst*

IN discussing lubrication problems with an internationally known lubrication expert recently, we discussed instances where he (the expert) does the diametrical opposite of what is commonly done in lubrication, namely, adds lubricant on stopping the drive instead of when starting. Instead of adding a few drops with an oil can; he turns on a sight-feed oiler. This method should interest most operators of oil machinery who may occasionally run into lubrication difficulties of this type.

This method is resorted to only in connection with the lubrication of ball and roller bearings when the bearings are adjacent to a source of high temperature. Thus, the method is employed for lubricating bearings that ordinarily give trouble due to excessive heat.

This method keeps the grease from hardening. If the oil were applied directly to the grease while the motor is in motion it would not have a chance to be absorbed by the grease because centrifugal force would cause the oil to be thrown out. Surprisingly high temperatures have been eliminated.

☆ ☆ ☆



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## FAIRBANKS-MORSE ZC ENGINES

- **NO SKILLED LABOR NEEDED**—Simplicity of design and accessibility of working parts makes it an easy job for the ordinary field man to service or repair the Fairbanks-Morse ZC Engine.
- **NO MACHINE SHOP NEEDED**—There is no need for a machine shop—the Fairbanks-Morse ZC can be completely serviced in the field, a saving in both time and transportation.
- **PARTS READILY AVAILABLE**—With proper care, the Fairbanks-Morse ZC Engine rarely needs a replacement part . . . however, when parts are needed they are readily available in all Continental stores.
- **DEPENDABLE AND DURABLE**—Engineered to run 24 hours a day—service is reduced to an occasional field adjustment.

The Fairbanks-Morse ZC Engine is truly an outstanding performer. Its simplicity will amaze you, making it a sure cure for today's maintenance headaches.

If you have any kind of a power problem check up on the Fairbanks-Morse Engine. There is a size to fit practically every requirement. Immediate deliveries can be made from stock. Ask your neighbor about his ZC Engines and you will readily learn how to reduce maintenance to a *Simple Field Service Job*.

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# CONTINENTAL

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# LAUGH WITH BARNEY

*Golfer:* Notice any improvement since last year, caddy?

*Caddy:* Had your clubs shined up, haven't you, sir?

* * *

A countryman came to town with a blind and half-starved looking old horse.

How much for the horse? asked a bystander.

One hundred dollars, replied the farmer.

I'll give you five dollars, said the prospective buyer.

The farmer looked at the other in amazement. Friend, he said, I ain't gonna let a small matter of ninety-five dollars stand between me and a horse trade. He's yourn.

* * *

An actor was very much in love with an actress in the same show. The actress was married and her husband was around frequently. They were certain, however, that hubby suspected nothing.

The affair lasted for over a year and ended only when the actress died. Attending the funeral, the actor wept loudly and long. The husband, after watching him curiously for a while, then patted him on the back.

"I know how you feel, old fellow," he murmured, "but don't cry, I'll get married again soon!"

* * *

Hundreds each morning I behold
Along the highways stalking;
Many are walking to reduce,
More are reduced to walking.

* * *

*Young Husband:* We're rather short on sleeping accommodations, old man. If you stay overnight you'll have to sleep in my twin bed.

*Finicky Guest:* Is it soft and comfortable.

*Young Husband:* Why...uh, yes... I think so.

* * *

The parlor had been exceedingly quiet and comparatively dark for more than one hour. The mother could stand the suspense no longer and finally called down:

"Lizzie, are you entertaining that young man down there?"

"No, mother," Lizzie replied, "we're just talking."

* * *

The duties of a young army officer kept him in China for several years. Returning, he was met at the dock by his charming wife. Atop the luggage sat a Chinese boy who, the officer explained, was too perfect a servant to leave behind . . . That night at home, a delicious dinner was prepared and served, and the following morning when the boy appeared with the breakfast trays the young wife realized that here really was a jewel. Later, while the husband was in the bathroom dressing, a rap on the bedroom door was followed by the smiling face of the China boy. "Time for missy go home," he said.

* * *

*He:* Does your lipstick come right off?

*She:* No, I always struggle a little first.

* * *

*First Steno:* Just because a man has money that doesn't mean he's a success.

*Second Same:* Nevertheless, I'll marry any failure who's got a million dollars.

* * *

### The Pilgrimage of Hygrade Oyl

By BILLY McGRAW

Old Hygrade Oyl stood at the gate,
And Heaven was his quest,
He'd spent his life where oil is found
And now he wanted rest.

We've no rest here, St. Peter said,
We've erred I greatly fear,
We've taken in a lot of men
From off your oily sphere.

They're drilling holes in every cloud,
And chasing anticlines;
They strip the harps of all their strings,
To make their drilling lines.

Old Hygrade scratched his head in thought,
Then as he looked about,
He said, I think I know a way
To get those roughnecks out.

I'll start a rumor going round,
Of Satan's latest well,
And soon you'll see them on their way,
They'll all go down to Hell.

The news was flashed from soul to soul;
The exodus began,
And Heaven, freed from talk of oil
Was bliss for any man.

But soon St. Peter at the gate
Saw Hygrade Oyl appear,
With luggage packed, and straightway asked,
Why art thou leaving here?

I beg your leave old Hygrade said,
I've thought it over well,
That rumor maybe has some truth,
I'm on my way to Hell.

—*Flying Carpet*
of Los Angeles Nomads

Don't fuss if you are getting older. If you weren't getting older you wouldn't be here at all.

* * *

*Sarah:* Why didn't you yell for help when that soldier kissed you?

*Mamie:* He didn't need any help.

* * *

### An Essay on Men

Men are what women marry; they have two feet, two hands, and sometimes two wives, but never more than one collar or one idea at a time. Like Turkish cigarettes, men are all made of the same material; the only difference is that some are a little better disguised than others. Generally speaking, they may be divided into three classes: husbands, bachelors, and widowers. An eligible bachelor is a mass of obstinacy entirely surrounded by suspicion. Husbands are of three varieties: prizes, surprises and booby prizes.

Making a husband out of a man is one of the highest plastic arts known to civilization. It requires science, sculpture, common sense, faith, hope and charity—especially charity. It is a psychological marvel that a soft, tender, violet-scented thing like a woman should enjoy kissing a big, awkward, stubby-chinned, tobacco- and bayrum-scented thing like a man.

If you flatter a man, it frightens him to death; and if you don't, you bore him to death. If you permit him to make love to you, he gets tired of you in the end, and if you don't, he gets tired of you in the beginning. If you believe him in everything, you soon cease to interest him. If you argue with him in everything, you soon cease to charm him. If you believe all he tells you, he thinks you are a fool, and if you don't, he thinks you are a cynic. If you wear gay colors and a bit of rouge and a startling hat, he hesitates to take you out; if you wear a little toque and a tailor-made, he takes you out and stares at women in gay colors, rouge and a startling hat all evening.

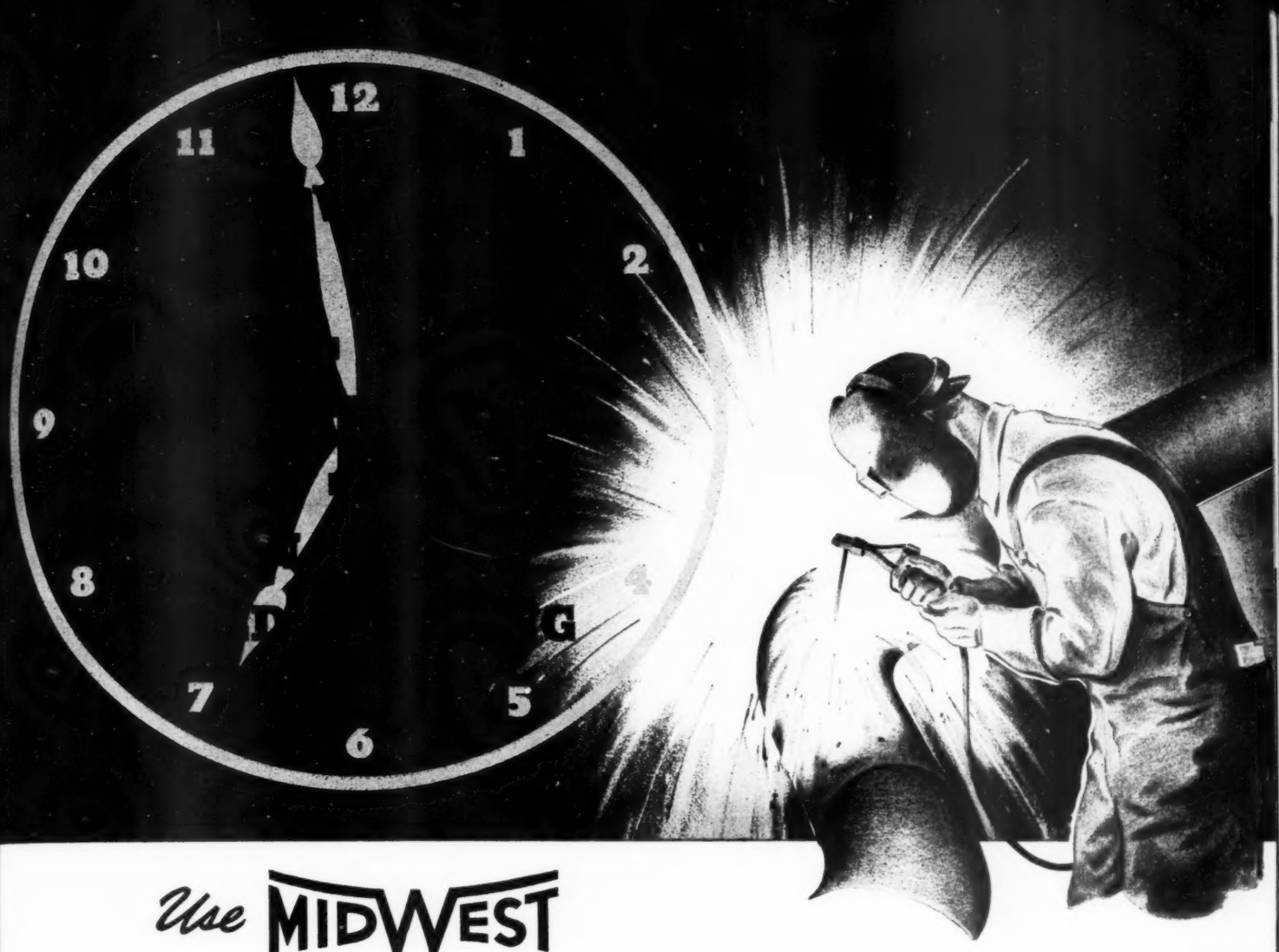
If you join him in his gayeties and approve of him in his smoking, he swears you are driving him to the devil; and if you don't approve of his smoking and urge him to give it up, he vows you are driving him to the devil.

If you are the clinging type, he doubts whether you have a brain, and if you are a modern, advanced and independent woman, he doubts whether you have a heart.

If you are silly, he longs for a bright mate, and if you are brilliant and intellectual, he longs for a playmate.

If you are popular with other men, he is jealous, and if you are not, he hesitates to marry a wallflower.

Gosh ding the men anyhow!



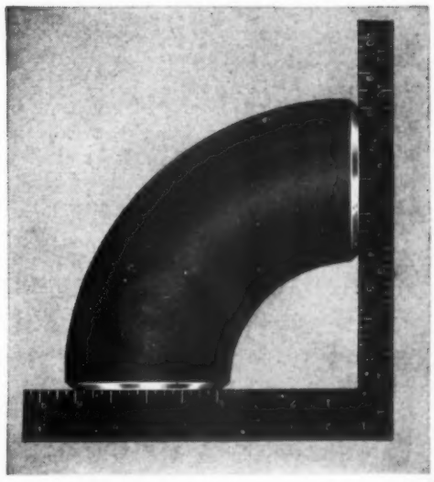
# Use MIDWEST

## WELDING FITTINGS

Now that "time" is the critical factor on so many welded piping jobs, it is more important than ever before to utilize the time-saving characteristics of Midwest Butt-Welding Elbows.

Qualified pipe welders report that Midwest Elbows save time and trouble on the job because they are always accurately to dimension . . . and because they are always uniform. Time is saved not only in lining up and in welding, but also because all pipe can be cut in advance according to drawings. Another important advantage is that more uniform welds are assured.

These features result from the design and from the unique process used in the manufacture of Midwest Welding Elbows. They are first made slightly oversize . . . then accurately sized in compression at a forging heat. Special fixtures and machine tools assure accurate finishing. Ask for Bulletin WF-41 which gives all the facts.



(above) Exact included angle is the result of special fixtures and tools developed by Midwest for machine-beveling the ends.

(right) Sectional view emphasizes uniform wall thickness and true circular cross-section of all Midwest Welding Elbows (both Standard and "Long Tangent").

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Sales Offices: Chicago—949 Marquette Bldg. • New York (Eastern Division)—30 Church St. Los Angeles—520 Anderson St. • Houston—229 Shell Bldg. • San Francisco—535 Call Bldg. Tulsa—533 Mayo Bldg.

MIDWEST WELDING FITTINGS SAVE TIME, IMPROVE THE DESIGN, AND REDUCE THE COST OF PIPING SYSTEMS

# Running Tour

## WITH MEN IN THE INDUSTRY

DONALD W. FAIRBAIRN has been named district manager of a new sales district for the National Sales and Service Division of The B. F. Goodrich Company for the Pacific Coast area, according to an announcement by G. E. BRUNNER, general manager of the division. Headquarters will be in Los Angeles, California.

WILLIAM R. EDWARDS, formerly salesman in the Industrial Products Division, has taken over Fairbairn's duties on rubber tracks. W. B. COLLIER has been named sales engineer on fuel cells. H. V. DWIGHT, formerly technical representative in the Washington office, is sales engineer on rubber tracks.

H. V. KIDWELL has been assigned to the Detroit district, working with the ordnance department there; R. A. MAXWELL has been named staff man on all tire problems other than aeronautical, and L. I. GIBBONS has been transferred to the company's field engineering department with headquarters in Detroit.

S. J. MODZIKOWSKI, chemical engineer of the Peoples Gas Light and Coke Company, Chicago, Illinois, has just been elected Commander of the Peoples Gas Post of the American Legion. Modzikowski was formerly active in American Gas Association work and has served as chairman of the Chemical Committee and vice-chairman of the Technical Section for a number of years. At present he is in charge of the physical and chemical testing laboratory of the Peoples Gas Light and Coke Company.

MERRITT L. SMITH, advertising manager of Metal and Thermit Corporation, has been appointed assistant sales manager of the corporation. Smith, with headquarters at 120 Broadway, New York, will continue to direct advertising activities for the company.

CARROLL W. JOHNSON has assumed his new duties as director of marketing for District 2 (Middle West) of the OPM. Johnson, with headquarters in Chicago, Illinois, succeeds E. E. OVERTON, acting director, who has gone to Washington for special work in connection with development in gasoline as a substitute for heavy oil products in various uses.

CHARLES D. YOUNG, formerly district manager of Metal and Thermit Corporation's Chicago office, has been appointed sales manager of the welding division of the firm. He is vice-president of the Railway Appliances Association.

DR. J. MITCHELL FAIN has been granted a leave of absence for the duration from his duties as chemical engineer at Foster D. Snell, Inc., consulting chemists-engineers of Brooklyn, New York. Major Fain has been called to active duty in the Chemical Warfare Service and is now stationed at the Chemical Warfare School, Edgewood Arsenal, Maryland.

Recent additions to the staff of the company include NORMAN FINE, ALVIN GRUDER, ANNE SULLIVAN, and HERBERT TERRY.

LAWRENCE E. SKELLY, connected with Young Radiator Company in an engineering and sales capacity for the last several years in Racine, Wisconsin, has been commissioned a lieutenant (j.g.) in the U. S. Navy Reserve and ordered to active duty. He is attending a training course at the University of Arizona prior to being assigned to duties in the Navy Air Corps.

WILLIAM J. BROWN, widely known to dealers, jobbers, and distributors in the New York State area as New York zone sales-manager of the original equipment division of the Minneapolis-Honeywell Regulator Company, has been transferred to a vital war production post. He is now attached to the Brown Instrument Company Division of Minneapolis-Honeywell and is in charge of expediting materials in the New York area.

JOS. E. ELLIOTT, manager industrial engineering, Southwestern Gas and Electric Company, Shreveport, Louisiana, has recently been commissioned a captain in the Engineer Corps, U. S. Army, and is at present stationed at a camp in Louisiana.

FRANK E. MOTT, assistant to W. C. Teagle of the Standard Oil Company of New Jersey, has been given a leave of absence by his company to accept a commission as lieutenant colonel with the U. S. Army Ordnance Department.

JOSUHA S. COSDEN, JR., president of the Cosco Oil Company, Wynnewood, Oklahoma, and son of the late J. S. Cosden, founder of the Mid-Continent Petroleum Corporation, has given up his position, enlisted in the marines, and is now in training in San Diego, California. JAMES NAGLE, Midland Oil and Fuel Company, Tulsa, Oklahoma, has accepted a vice-presidency in the company and will act in a supervisory capacity.

T. E. SWIGART, national chairman of the American Petroleum Institute, has named four user members to the Institute's subcommittee on pumps and the subcommittee on sucker rods to give these functional groups representation from manufacturers and users, to simplify deliberations at meetings. Appointed to the Institute's committee on pumping equipment and engines are D. O. BARRETT, Gulf Oil Corporation, Tulsa, Oklahoma; J. E. ECKEL, Humble Oil and Refining Company, Houston, Texas; GLENVER MCCONNELL, Shell Oil Company, Inc., Tulsa, Oklahoma, and H. N. MARSH, General Petroleum Corporation, Los Angeles, California.

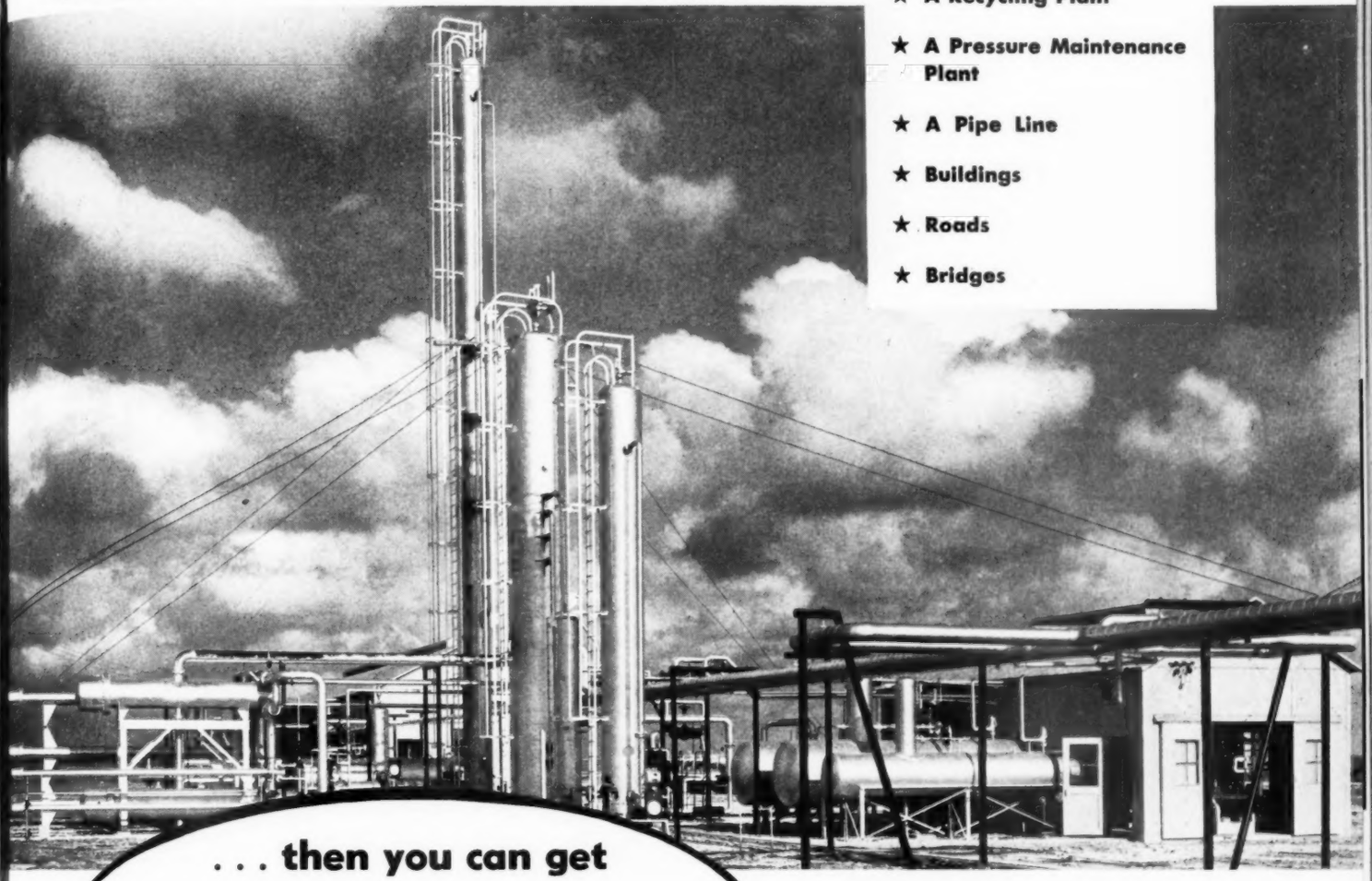
FRANK BUTTRAM, geologist and oil man of Oklahoma City, Oklahoma, was reeletced for a fourth term as president of the Independent Petroleum Association of America at the annual meeting of the directors. Other officers named include HAROLD B. FELL, Ardmore, executive vice-president; RUSSELL B. BROWN, Washington, D. C., general counsel; N. T. GILBERT, Tulsa, treasurer; C. E. BUCHNER, Tulsa, executive manager; J. GARFIELD BUELL, Tulsa, vice-president for eastern Oklahoma, and R. OLSEN, Oklahoma City, vice-president for western Oklahoma. Buell succeeds CURTIS E. BRYAN, Tulsa, named to the executive committee. Elected to the directorate are H. C. ARNOLD, vice-president British American Oil Producing Company, Tulsa; C. E. BURLINGAME and J. H. KANE, independent operators of Bartlesville, Oklahoma.

OSCAR E. WAGNER, JR., Wheeling, West Virginia, district geologist for The Texas Company, has resigned to accept a post as district geologist for Illinois and Indiana with the Mid-Continent Petroleum Corporation.

ROSS B. CHAMBERS, Ventura, California, drilling foreman for Shell Oil Company, has been promoted to division drilling foreman. He will make his headquarters both at Los Angeles, where the company maintains its Los Angeles Basin Division headquarters, and at Long Beach.

# ARE YOU PLANNING

- ★ Refinery Construction
- ★ A Gasoline Plant
- ★ A Recycling Plant
- ★ A Pressure Maintenance Plant
- ★ A Pipe Line
- ★ Buildings
- ★ Roads
- ★ Bridges



## . . . then you can get complete, responsible service from H. B. Zachry Company

**The high pressure Francitas Cycling Plant (shown above) was in successful operation well within the specified time.**

We are prepared to handle prime contracts, on a turn-key basis, or sub-contracts of any size quickly and efficiently . . . assuming full responsibility for all phases of the work.

**OVER $20,000,000 in Army Air Bases** successfully completed by Zachry since January. Work includes grading, sewers, water, electric systems, buildings, run-ways, and streets.

**Advanced design** insures top efficiency in Zachry designed projects. Recognized architects and engineers are retained to design these projects. The H. B. Zachry Company is prepared to assist in financing your project if desired.

**All contract conditions satisfied.** Adequate financial backing, long experience and millions of dollars per year in successfully completed contracts is your assurance that all conditions will be satisfied.

Your request for further information will be promptly answered. We shall be pleased to talk over your problems and furnish suggested designs and cost estimates.

***Turn construction worries over to us***

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2019 LINCOLN ST.

J. B. MILAM, Claremore, Oklahoma, was reelected president of the Oklahoma Stripper Well Association at the annual meeting of the association held in Tulsa, Oklahoma. All officers of the association were reelected and include HOWARD J. WHITEHILL, Tulsa, secretary and treasurer, and D. G. POWELL, Tulsa, executive vice-president. HERBERT GUSSMAN, Tulsa, was elected chairman of the budget committee and given the privilege of selecting his own committee from the membership for the purpose of conducting a vigorous campaign to raise funds for carrying cut the work of the association.

R. E. ARRANT is now district manager for Sinclair Refining Company at Columbus, Texas. He formerly was at Houston, Texas.

M. P. L. LOVE is the new head of the research laboratory at the Shell Oil Company's refinery at Houston, Texas. He succeeds DR. HAROLD GERSHINOWITZ, who has been transferred to New York City. Love moves to Houston from New York.

J. M. ALEXANDER, who has been at Negritos, Peru, for International Petroleum Company, has returned to the United States and is now at Roshacon, Texas.

B. L. THORNE recently was elected president of the Alberta Petroleum Association, to succeed HERBERT GREENFIELD. F. M. GRAHAM was reelected vice-president and E. W. KOLB, secretary-treasurer. JOHN GALLOWAY, vice-president of the Standard Oil Company of British Columbia, was made a director of the organization.

GABRIEL CUERVO, connected with the Petroleum Department of the Republic of Colombia for more than 13 years, is now enrolled at the University of Texas. He is a graduate of the National University of Colombia.

CECIL HAGEN, consulting geologist, Houston, Texas, has been made a lieutenant (j.g.) in the United States Navy. He is stationed at Washington, D. C.

R. V. BEBOUT, drilling contractor of Fort Worth, Texas, has been employed by the Bolivian Government as drilling superintendent of Yacimientos Petroliferos Fiscales Bolivian.

ARNO BEHNKE, assistant superintendent of production for Amerada Petroleum Corporation in the Fort Worth, Texas, district, is now with the United States Navy as a lieutenant in the administrative command.

RAY DIMIT, Wichita Falls, Texas, petroleum engineer for Shell Oil Company, Inc., has enlisted in the Naval Reserve and is stationed at New York City.

G. S. TAITT is now making his headquarters at Bakersfield, California, for Shell Oil Company, Inc. He recently returned from Trinidad.

G. H. MCCARTHY, who has been with the Sunset Oil Company of California, has been made general manager of Franco Oils and Vermilion Consolidated Oils, Vermilion, Alberta, Canada.

P. McDONALD BIDDISION

P. MCDONALD BIDDISION, consulting engineer of Dallas, Texas, has closed his office to serve with the War Production Board. His address is now War Production Board, Power Branch, Gas Supply Section, Room 2703, Temporary "R" Building, Washington, D. C.

W. W. VIETTI, who has been manager of the Colombian Petroleum Company, Colombia, South America, has returned to the States and is now with The Texas Company at Houston, Texas.

G. H. WHITE has been made assistant exploration manager of the Texas Gulf area by Shell Oil Company, Inc. He succeeds W. H. HAMM, resigned.

J. W. GALLAGHER, who has been at Caripito, Venezuela, for Standard Oil Company of Venezuela, has returned to the United States and joined the Army. He has been commissioned a second lieutenant and is stationed at Camp Claiborne, Louisiana.

CLIFTON M. KEELER has been made a member of the food administrator's staff in the West Indies and is stationed at St. Thomas, Virgin Islands. He has been a consulting petroleum engineer and geologist practicing in Texas and Oklahoma.

JAMES D. BALL, farm boss for Humble Oil and Refining Company in the Government Wells, Texas, district, has been transferred to the Kelsey, Texas, district as assistant district superintendent.

WILLARD G. WIEGEL, advertising manager, has been made personnel manager by the Lone Star Gas Company, Dallas, Texas.

R. E. GILE, consulting geologist, Midland, Texas, has accepted a position as division geologist for the West Texas-New Mexico area of the Bay Petroleum Corporation. This company has recently entered the Permian Basin area and has established an office at Midland.

J. W. VAIDEN, vice-president in charge of the manufacturing division, and T. A. DOCKWEILER, attorney, have been elected to the board of directors of the Skelly Oil Company.

D. W. WHITLOW, who has been with Bridgeport Machine Company, has accepted a position with Republic Supply Company at Tulsa, Oklahoma.

V. G. COLE is now district geologist at Wichita, Kansas, for Gulf Oil Corporation, succeeding ANTHONY FOLGER, who resigned to enter consulting work.

R. S. COOKE, engineer for the Carter Oil Company in the Seminole, Oklahoma, area, has been transferred to Great Bend, Kansas.

R. H. NEWTON, general superintendent for Gulf Oil Corporation in Venezuela, is visiting in the United States.

H. G. COLE, engineer, Phillips Petroleum Company, is now stationed at Oklahoma City, Oklahoma. He has been at Aetna, Kansas.

G. FRANK ALDRICH, geologist and independent operator at Midland, Texas, has reported for Army duty at San Antonio, Texas. He held a captain's commission in the reserves.

M. E. MONTROSE, vice-president of Lane-Wells Company, has returned to his headquarters in Los Angeles, California, from a seven weeks' trip through the Mid-Continent and Gulf Coast areas and also through the East, where he visited plants of some of the nation's leading machine-tool manufacturers. Lane-Wells operations during the last year have been expanded to include the manufacture of specialized machine-tool accessories for the metal-working and oil-tool industries.

# 5½ POUNDS of STEEL

## *Will get you a Well with that "HARD-SHOOTING"*

# MC CULLOUGH GUN PERFORATOR

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| Victoria, Texas | Houma, La. | Seminole, Okla. | Ventura, Calif. |
| Corpus Christi, Texas | Shreveport, La. | Mt. Vernon, Ill. | Avenal, Calif. |

McCULLOUGH TOOL COMPANY ★ 5820 South Alameda St., Los Angeles, Calif.

# MACHINERY and EQUIPMENT

## A-C All-Position Welding Electrode

A NEW electrode designed specifically for all-position welding of mild steel with a-c. type welding machines has been developed by Air Reduction Sales Company in 1/8- and 5/32-in. diameter. The Airco No. 230 electrode complies with all requirements of the American Welding Society Classification E6011, American Bureau of Shipping, Group HlG and BlG for a-c. and other specifications qualifying it for use on war work, according to the manufacturer.

The high quality of deposited metal of the No. 230 electrode is fully comparable to that of the best d-c. reverse polarity all-position electrodes, it is asserted.

Following are physical test results made on all-weld-metal tensile specimens:

| | |
|---|---|
| *As welded* | |
| Ultimate tensile strength | 70,000-75,000 |
| *Stress relieved* | |
| Ultimate tensile strength | 65,000-70,000 |
| *As welded* | |
| Percent elongation in 2-in. | 25-30% |
| *Stress relieved* | |
| Percent elongation in 2-in. | 30-35% |

An outstanding characteristic of this a-c. electrode is that average operators have no difficulty in obtaining good fusion and complete penetration, it is stated. The finished weld deposit is quite smooth and has a uniform surface contour.

## Safety Hat

A NEW safety hat, made of laminated bakelite, and known as the type "P" hat, has been introduced by the B. F. McDonald Company, West Coast manufacturers of safety equipment. It replaces for the duration the company's well-known type "T" metal hat and incorporates the same headband suspension, making the hat quickly and easily adjustable to all head sizes, it is stated.

Features of the type "P" plastic hat are its lightness, exceptional strength, and resistance to heavy blows. Adequate ventilation (the same as provided in the "T" hat) keeps the head cool in hot weather, and the hat's lightness makes it comfortable to wear over day-long periods. Its good looks are said to be welcomed by workmen who wear the hat to and from jobs without feeling self-conscious. The headband is fully suspended to provide a cushioning hammock against the shock of heavy blows. The hat may easily be cleaned or sterilized by steaming or any other preferred method.

A bulletin on the new type "P" hat may be obtained from B. F. McDonald Company, 1248 South Hope Street, Los Angeles.

## Thermoplastic Lining For Storage Tanks

AMERCOAT, a plastic base coating of thermoplastic resins, makes it possible to use concrete as well as steel for tanks and vats for storage of various fluids that ordinarily would cause severe corrosion or costly seepage. By using Amercoat as the lining, concrete tanks are now being used to store millions of barrels of Diesel fuel at strategic points. Amercoat adheres tightly to the concrete surface and is impervious. It produces a smooth, inert surface that is plastic enough not to check, crack, or fracture when subjected to vibration and moderate expansion and contraction. Concrete tanks lined with Amercoat are not subject to corrosion and there is no seepage, the makers state.

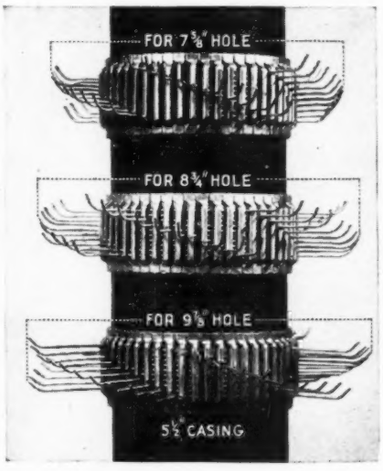
Amercoat makes it possible to use concrete tanks for storing materials containing acids, alkaline, or caustic compounds. This represents a substantial saving in critical materials as well as saving the time lost while waiting for deliveries of these materials.

Amercoat is odorless, tasteless, chemically inert, and dielectric to a high degree. It is cold-applied and can be brushed or sprayed on metal or concrete without requiring special tools or equipment for application. All Amercoat products are modified and pigmented to meet stipulated problems.

Amercoat is manufactured by American Pipe and Construction Company, P. O. Box 3428, Terminal Annex, Los Angeles, California.

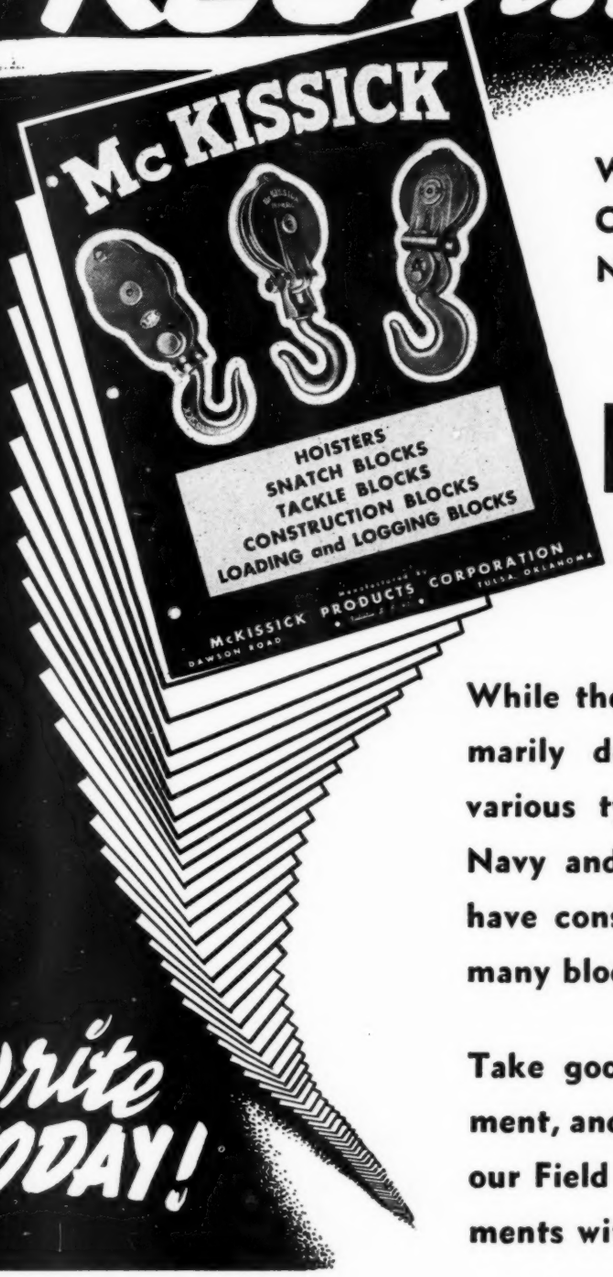
## Cementing Guides for Various Clearances

WALL cleaning Guides are now supplied by B and W, Inc., for various clearances between the casing and wall of the hole. Short, standard, and long wire lengths now are available




for such combinations as 5½-in. casing in 7⅞-in., 8¾-in., or 9⅞-in. hole. The outer wire diameter usually is 1½ to 2 in. greater than the hole diameter, to provide centering by the torque spring action of the steel wires, and mud removal by scratching the face of the formation. Special wire lengths also are available for mud removal during open hole or gravel-packing operations.

# Now Ready For FREE Distribution

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## McKISSICK BLOCKS

While the facilities of our plant are primarily devoted to the production of various types of blocks for the Army, Navy and other Defense Industries we have constantly improved the design of many blocks now used in the oil field.

Take good care of your present equipment, and when Victory comes let one of our Field Men check your Block requirements with you.

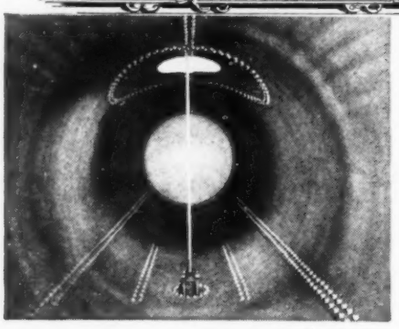
*Write TODAY!*

## McKISSICK PRODUCTS CORP.

TULSA, OKLAHOMA

A NAME EVERY ENGINEER SHOULD KNOW

Amercoat



Helps to solve vital shipping problems...

Tank cars, lined with *Amercoat,* which formerly carried bulk shipments of fine wines now transport essential chemicals to war industries. The same *Amercoat* lining which protected the delicate flavor of wines from contamination now protects these same tank cars from corrosion caused by more powerful chemicals.

*Amercoat* is odorless, tasteless, chemically inert and dielectric to a high degree. All *Amercoat* products are compounded of inert synthetic resins, but each is modified and pigmented to best meet stipulated problems.

Tell us *your* problem... and we'll answer it with *Amercoat*... or tell you *Amercoat* is not the answer.

COLD-APPLIED ON METAL OR CONCRETE

*Amercoat* has successfully solved problems of corrosion or contamination in the Chemical, Petroleum, Maritime, Food and many other industries. Write for Illustrated Bulletin which gives complete details.

Amercoat DIVISION

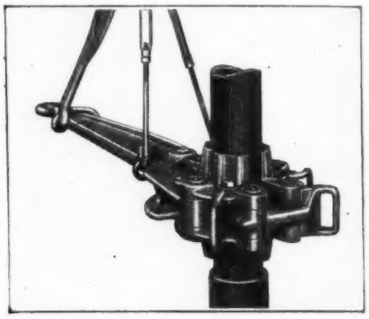
AMERICAN PIPE AND CONSTRUCTION COMPANY

P. O. BOX 3428, TERMINAL ANNEX • LOS ANGELES, CALIFORNIA

## Bushings for "Drill Casing"

THE increasing use of casing for the drilling string instead of the usual drill pipe is responsible for the development of the BJ Drill Casing Bushings for making-up or breaking-out "drill casing."

When casing is used for the drilling string a special type of tong is required, particularly to break-out tight joints of the comparatively thin-walled casing. These drill casing bushings are provided with a 12-in. bearing surface, and are bored to contact the entire circumference of the casing. Two of the four bushings are equipped with die slots into which are fitted three 4-in. knurled BJ Long Dies bored to the diameter of the casing upon which they are to be used.



In service these new Drill Casing Bushings break out the tightest joints without crimping or bottlenecking the casing, even after repeated round trips of the drill casing, the makers say.

Another successful use of these bushings is for setting any type of thin-walled casing, or for removing corroded casing that has been in the well for a long period of time, it is stated.

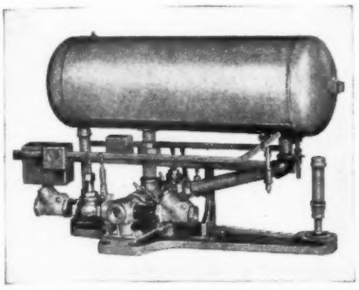
Detailed information on this equipment can be obtained from Byron Jackson Company, Houston, Texas, Los Angeles, Calif., or New York City.

## Water Testing Equipment

A NEW series of Water Test Sets is announced by W. H. and L. D. Betz, Gillingham and Worth Streets, Frankford, Philadelphia, Pennsylvania. These "A" Series Test Sets include the necessary chemicals and apparatus for determining hardness, alkalinities, chlorides, phosphates, and sulfites in water, when any two, three, or four of these tests are required. A special cabinet designed for use on table or wall is provided. All chemicals and apparatus are contained in the cabinet, held in a secure position and ready for instant use. A portion of the opened cabinet door forms a convenient acid-resistant laboratory work table, and a fluorescent light provides correct illumination for the tests. The protection afforded by the cabinet minimizes breakage and eliminates errors caused by dust or dirt.

### Three -Valve Tilt Trap

A NEW three-valve tilt trap for variable pressures on lifting service has been added to the line of deaerating systems for steam drainage and boiler feeding made by the W. M.



Acker Organization, Inc., Cleveland, Ohio. The sturdy construction of female trunnion supported on center bearings, and male steam and water ends, which are relieved of any weight carried on the packing, is the same as that used on the basic Acker return and non-return tilt traps.

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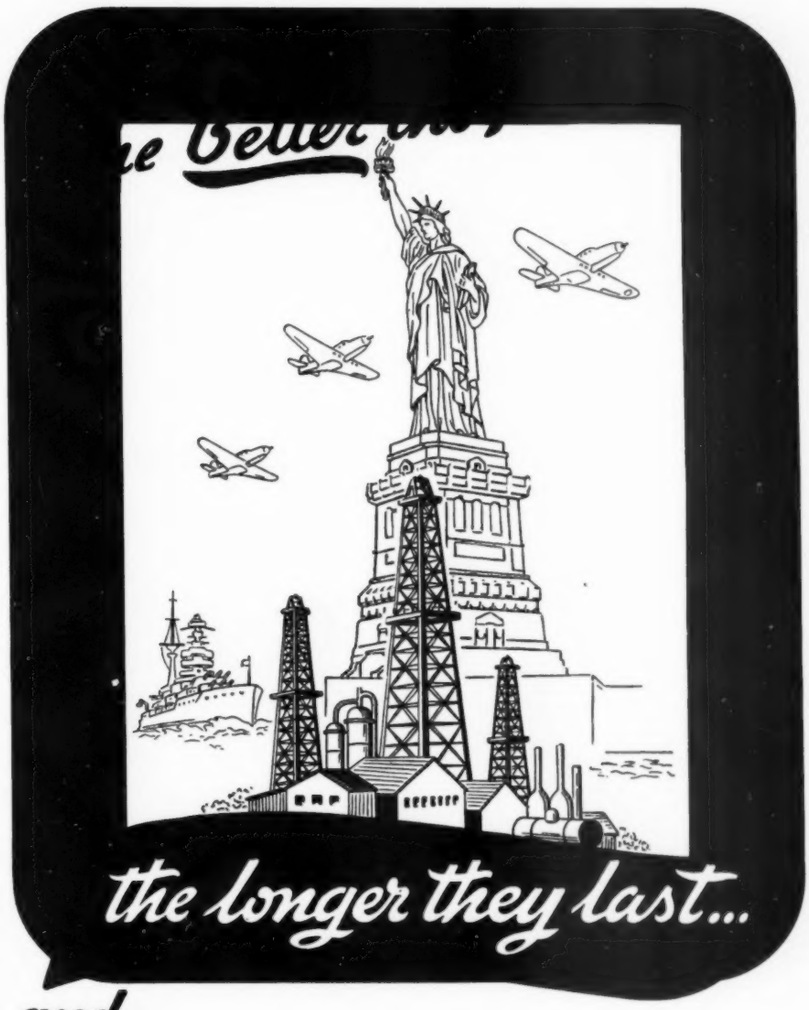
### Special Work Holding Fixture

THE Landis Machine Company, Waynesboro, Pennsylvania, manufacturers of thread cutting machines, die heads, collapsible taps, etc., has recently developed a special work holding fixture for use with its Landmaco machine for threading vital components required in industry. This special work holding fixture provides a means for accurately and rigidly supporting the work piece during the threading operation.

The fixtures provide a work aligning arbor on which the work is retained by a collar that fits a square, milled close to the end of the arbor. A lever-operated cam arrangement at the rear end of the arbor provides a means for drawing and locking the work piece onto two driving and locating pins.

The special work holding fixture is fastened to a face plate that bolts to the machine carriage in place of the conventional carriage front or vise. The fixture has both horizontal and vertical adjustment on the carriage to assure accurate and permanent alignment of the work piece with the center of rotation of the threading unit. This fixture was designed with a view of holding to within extremely close tolerances for thread concentricity, and to assure maximum production by eliminating the time otherwise required if the work piece were gripped in the conventional vise.


and—
THE LONGER THEY LAST the better

The HIGHER STANDARD

It's always been wise to buy the best tools available . . . now it's *vital!* Every day added to the useful life of a piece of oilfield equipment means time and material saved to insure our liberty. Those who, even in normal times, have known that Spang Cable Tools offer a longer period of efficiency, are more grateful than ever now for these "Higher Standard" Tools.

SPANG & COMPANY, BUTLER, PA.

SPANG NAME IN CABLE TOOLS

## Van Tassel Advanced in G-E Motor Division

K. R. Van Tassel has been appointed manager sales of the newly formed Integral-horsepower Motor Section of the General Electric Company's Motor Division, it was announced recently by W. H. Henry, manager of the Motor Division, Industrial Department. At the same time, Henry announced that D. A. Yates, of the same division, had been placed in charge of the Lynn Motor Group at G-E's Lynn, Massachusetts, plant.

Van Tassel, a native of Geneva, New York, was graduated from the Massachusetts Institute of Technology in 1925 and joined the General Electric Company as a student engineer the same year. In 1926, he was transferred to the Transformer Engineering Department, Pittsfield, Massachusetts, where he remained until 1928, when he entered the Single-phase Motor Department there. Later he was made designing engineer for that department. In 1932, he was transferred to the Fractional-horsepower Motor Engineering Department, Fort Wayne, Indiana, later becoming a commercial engineer in this department and also a staff assistant to the manager of the Fort Wayne Works. Since 1940, Van Tassel has been manager sales of Lynn Motors, at General Electric's Lynn Works.

Yates was graduated from Oklahoma University in 1930 and entered General Electric's employ as a student engineer the same year. In 1931, he was transferred to the Machinery Manufacturers Section of the Industrial Department and a year later was transferred to the Motor Division.

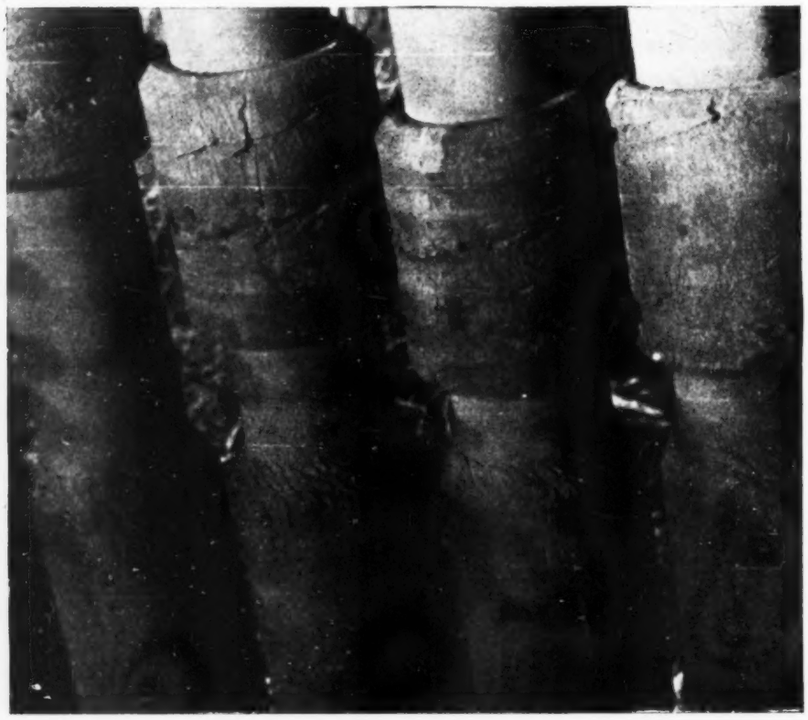
In announcing Van Tassel's appointment, Henry also announced that the commercial activities and personnel of the Company's Lynn Motor Section, the Schenectady Motor Section, and the d-c. motor and generator group would be consolidated to form the new Integral-horsepower Motor Section. The other two sections of the Motor Division are the Fractional-horsepower Motor Section, and the Large Motor and Generator Section.

## T. H. Corpe General Sales Manager Elastic Stop Nut

Thomas H. Corpe has been named general sales manager of the Elastic Stop Nut Corporation, it is announced by William T. Hedlund, president of the company. This concern manufactures a self-locking nut, and has its general offices and main plant in Union, New Jersey. A branch plant was recently opened at Lincoln, Nebraska.

THOMAS H. CORPE

Corpe was formerly assistant general sales manager of the Lockheed Aircraft Corporation, and at one time was in charge of sales promotion, advertising, and market research for that company. He also has been associated with General Motors Corporation as a technical engineer in charge of its proving ground, and in various sales and promotion positions. He was educated at Oxford and at the University of Michigan. Corpe resides at Summit, New Jersey.

# These Protectors sure went through hell!

Battle-scarred? Sure. But they have a right to their looks. This string of Patterson-Ballagh Protectors was placed in service 'way back in 1937—more than five years ago, in Northern Louisiana.

The pipe is still serviceable; so are the Protectors.

Tens of thousands of feet of hole have been drilled. The drill pipe has far exceeded normal life. That's service—and a tribute to the conservation of steel, made possible with Patterson-Ballagh Protectors.

Since these Protectors were placed in service, added improvement to the rubber, plus lips, give the Product even greater life.

**PATTERSON-BALLAGH CORPORATION**

Los Angeles Houston New York City

**PATTERSON-BALLAGH PROTECTORS**

## Corrosion Division of Electrochemical Society Formed

At the Fall convention in Detroit of The Electrochemical Society, the Corrosion Division was organized. At this meeting the by-laws were adopted and the following officers were elected:

Chairman: L. G. Vande Bogart, Research and Development Laboratories, Crane Company, Chicago, Illinois.

Vice-chairman: H. H. Uhlig, General Electric Company Research Laboratory, Schenectady, New York.

Secretary-treasurer: R. H. Brown, Metallurgical Division, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pennsylvania.

The Corrosion Division was organized because of the interest displayed by a large number of the members of The Electrochemical Society in this phase of the work. The object of the Division is to coördinate the interests of the Society relating to corrosion, with individuals and organizations particularly interested and active in this field, to solicit papers, and plan symposia. Members of the Society interested in corrosion are eligible for membership in the Corrosion Division. Persons who are not members, but who are particularly interested in corrosion work, are invited to join The Electrochemical Society and participate in the work of the Corrosion Division.

## W. T. Powell Made a Vice-President of Emsco

Emsco Derrick and Equipment Company announces the appointment of William T. Powell as a vice-president of

WILLIAM T. POWELL

that company effective October 1, 1942. Powell was born in Treorchy, Wales, on December 22, 1901. He is a mechanical engineer; was graduated from the South Wales and Monmouthshire School of Mines in 1923, holds a mechanical engineering certificate of City and Guilds of London Institute, and is a member of the American Society of Mechanical Engineers.

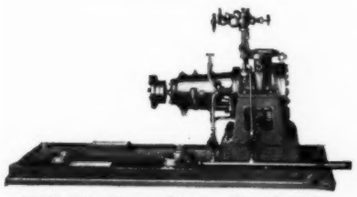
Prior to 1929, when Powell came to the United States, he was associated with the Bedwas Navigation Colliery Company as assistant chief engineer of that company's Bedwas mine.

He became a citizen of the United States in 1935 and, since taking up residence in this country, has been associated successively with the C. & A. Mining Company, Ajo, Arizona; the Dicalite Company, Torrance, California; the Kelco Company, San Diego, California, and the American Potash and Chemical Corporation at Trona, California.

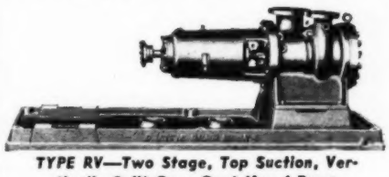
Powell entered the Emsco organization on August 1, 1937, in the fabricated plate division. Since the beginning of the present emergency he has devoted his entire time to Emsco's effort in the production of war materials. He has been manager of the War Materials Division since that division was organized in June, 1941. Powell is well known in procurement circles of the Army, Navy, aircraft, and other major war material manufacturers. He will continue to carry a major part of the responsibility that Emsco has assumed in its contribution to the war effort.


# Watch PACIFIC Pump performance NOW!

*TYPE I—Hot Oil, Multi-Stage Horizontal, Forged Steel Shell, Double Case, High Pressure Centrifugal Pump*



*TYPE SV—Single Stage, Top Suction, Vertically Split Case Centrifugal Pump*



*TYPE RV—Two Stage, Top Suction, Vertically Split Case Centrifugal Pump*

Watch carefully the day-after-day performance of PACIFIC Pumps in America's refineries, in power plants, in pipeline service, in oil wells, in deep water wells and in process plants. Ask the engineers who are responsible for the maintenance of pumping service in these vital industries. Learn for yourself how PACIFIC's advanced engineering, developments in metallurgy and precise workmanship assure long, dependable, trouble-free operation.

In this war of machines—watch PACIFIC Pump performance—and see why experience has proved "You can't buy a better pump than PACIFIC."

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# PACIFIC
# REFINERY PUMPS

## Emsco Advances Blake Caldwell

Blake Caldwell has been advanced to the position of manager in charge of all operations of the D + B Mid-Continent Division of Emsco Derrick and Equipment Company, a post for which he is well qualified by experience gained in his former capacity as chief engineer of the D + B Division.

Caldwell was born in Gainesville, and is a graduate of A. & M. College of Texas, receiving the bachelor of science degree in engineering in 1927, and a master of science degree in 1929. He also has a three-year term as a member of the A. and M. faculty to his credit as a teacher of chemistry and engineering drawing. His early training was acquired as assistant engineer for the Gulf Refining Company at Port Arthur, Texas, and as engineer for the Tulsa Boiler and Machinery Company of Tulsa, Oklahoma. Prior to his first connection with Emsco in 1940, he was chief engineer of the Walter O'Bannon Company for a period of nine years.

Caldwell's wide technical knowledge of oil-field problems has gained for him recognition as one of the foremost engineers of the country. While in Tulsa he was a charter member of the Tulsa Engineers' Club, and for the last ten years he has been actively engaged in A. P. I. standardization work. At the present time he is chairman of the Subcommittee of Rating Hoisting Tools,

BLAKE CALDWELL

secretary of the Manufacturers' Subcommittee on Pumps, and a member of the Manufacturer's Sub-committee on Sucker Rods.

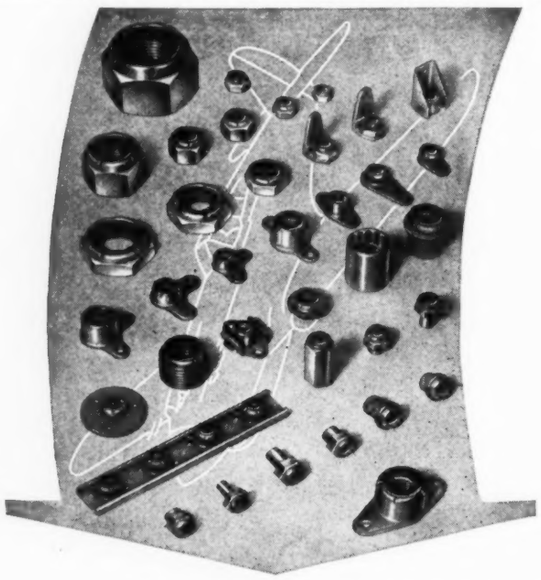
## R. C. Session Goes with Brown Fintube Company

Robert C. Sessions of the consulting engineering firm of Sessions and Sessions, Cleveland, Ohio, has been appointed chief engineer of The Brown Fintube Company, Elyria, Ohio.

Sessions, who is a member of A. S. M. E. and A. I. E. E., was graduated from

ROBERT C. SESSIONS

Worcester Polytechnic Institute in 1919 in electrical engineering. He was a fellow of the American Scandinavian Foundation in Sweden during 1919 and 1920, and was for some time in charge of the engineering and experimental division of Steel and Tubes, Inc., before entering consulting work. The firm of Sessions and Sessions, consulting engineers, is being continued with offices in the Rockefeller Building, Cleveland, under the active direction of Frank L. Sessions, senior partner of the firm.

FASTENINGS YOU CAN TRUST

1. Application is fast and fool-proof...
Their locking action is immediate and automatic . . . no pins, no washers, nothing to forget.

2. Grip is positive, yet resilient...
Threads of nut and bolt are held in contact under constant cushioned pressure. The nuts stay put.

3. The locking element does not fail...
Made of non-metallic, non-fatiguing material, it cannot be broken down by vibration or prolonged hard service.

There are more Elastic Stop Nuts on America's airplanes, tanks, guns, Naval vessels, and production equipment, than all other lock nuts combined.

» *Write for folder explaining the Elastic Stop self-locking principle*

ELASTIC STOP NUT CORPORATION • 2365 VAUXHALL ROAD • UNION, NEW JERSEY

WITH THE RED LOCKING COLLAR . . . SYMBOL OF SECURITY

## Bullard Changes Denver Address

The Denver, Colorado, office of E. D. Bullard Company, manufacturers and distributors of industrial safety equipment, has been changed to 18 Wazee Market. The former address was 56 Wazee Market. Howard Timms, who has been in charge of this office since the resignation of Tom Hallinan, who joined the Army, remains as district manager for the states of Colorado and Wyoming..

## J. B. Jenkins Advanced by Twin Disc Clutch Company

The Twin Disc Clutch Company, Racine, Wisconsin, announces the appointment of John B. Jenkins as manager of the Hydraulic Division, Rockford, Illinois.

For the last eight years, Jenkins has been in charge of the company's factory branches at St. Louis, Tulsa, and Dallas.

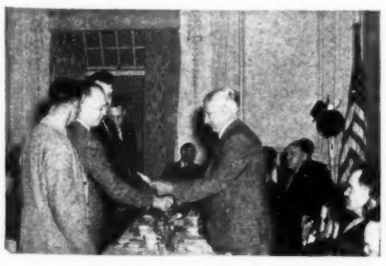
The active field experience that he brings to this position plus his previous experience at the Twin Disc factory in Racine, will assure Twin Disc customers a sympathetic understanding of their problems and the complete coöperation of the Hydraulic Division.

## Baker Awards Service Pins

The California Division of Baker Oil Tools, Inc., presented service pins to its employees in recognition of five, ten, fifteen, and twenty years' service, at a banquet held in the Wedgewood Room of Carl's Viewpark Restaurant in Los Angeles, the evening of October 3. T. Sutter, executive vice-president and general manager, acted as master of ceremonies.

One hundred and seventy-five employees were in attendance. An even hundred service pins were awarded, including a special platinum and diamond founder's pin presented in turn to R. C. Baker by the employees.

Baker, president and founder of Baker Oil Tools, Inc., is considered one of the



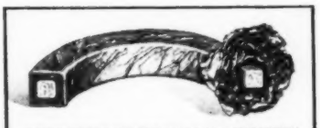
*R. C. Baker, Sr., presenting 10-year pin to R. W. Beals*

oil equipment industry's outstanding pioneers and inventors. His colorful history covers a span of 50 years, going back to 1893 when he first went to Los Angeles as a contractor-producer. In 1913 he founded the Baker Casing Show Company at Coalinga, California. Shortly thereafter the present corporation was formed, and in 1922 the company moved its headquarters to Los Angeles. Today manufacturing plants and offices are maintained at Los Angeles, Coalinga, and Houston, with branch offices and representatives throughout the important oil-producing territories of the United States and South America.

Many of the 52 former Baker employees, now in the armed forces, also earned service pins that the company is holding for them until they return from their fighting job with Uncle Sam.

Honored guests for the evening included Captain George Serfass and Captain Joseph W. Campbell of the U. S. Army Ordnance Department.

A similar banquet and presentation ceremony will be held in the near future at the company's Central Division headquarters in Houston. Service pin awards will be made to employees there by C. E. Whitney, vice-president and manager of Baker's Central Division operations.



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1. Processed to retain lubrication.
2. Provides readier response to gland pressure.
3. Distributes frictional load over several diagonally wrapped metallic sheets.
4. Originated by DURAMETALLIC.

**THERE'S A WAR TO BE WON!**

**Pump room performance is important! This is no time to handicap the efficiency of your pumps with make-shift packing . . . specify DURAMETALLIC twisted, flexible metallic packing and be assured of long runs, better sealing and friction-free service.**

WRITE TODAY FOR INFORMATION ON THE RIGHT TYPE PACKING FOR YOUR NEEDS

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The PERFECT SEAL

KALAMAZOO MICHIGAN

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# License Requirements for Canada Lifted

Removal of export license requirements for commercial shipments from the United States to consignees in Canada and that part of Labrador under Canadian control is announced by the Office of Exports, Board of Economic Warfare. As a result, exporters no longer will be required to obtain general, individual or any other kind of license to ship articles, materials, supplies, and technical data to those destinations.

Until the current revision, United States commercial commodities in most cases have been shipped to Canada under general licenses, each of which authorized goods to be exported whenever purchased and for unlimited periods of time. Even this "general license" requirement has now been removed, eliminating all license controls over commercial exports to Canada. This action is a further step in BEW measures to assist in promoting full and free exchange of materials across the Canadian border, in the joint war effort.

Exporters and manufacturers have been notified by the Office of Exports that the general license symbol "G-1", signifying a Canadian consignee, need no longer be displayed upon their export declarations. License symbols formerly required to be shown on envelopes, wrappers, or other containers holding technical data can now be omitted.

Collectors of Customs have been advised that any provision of past instructions in conflict with the abolition of these controls is modified accordingly.

# PD-311 Mandatory for Foreign Preference Ratings

Mandatory use of Form PD-311 by oil operators requiring priority assistance and export authority for materials used in operations outside the United States, its possessions and its territories has been ordered by the War Production Board in Preference Rating Order P-98-d.

Announced at the same time was a revision of Priorities Regulation No. 9, eliminating the requirement that a person wishing to export material must file with his suppliers an export license to cover each purchase order. Under the new system, following assignment of a preference rating on Form PD-311, a prescribed certification that an export license has been issued to the purchaser is sufficient.

Previously operators were permitted to apply for priority assistance by filing data either on Form PD-311 or on Form PD-1A.

Form PD-311 requires operators to file data reviewed by the War Production Board, the Board of Economic Warfare, the Lend-Lease Administration, and the Office of Petroleum Coordinator for War.

Instructions for filling out Form PD-311, revised, have been issued by the War Production Board upon the recommendation of the Office of Petroleum Coordinator for War.

Copies of the instructions may be obtained by writing to the "Director of Foreign Division, Office of Petroleum Coordinator, South Interior Building, Washington, D. C., Ref: PD-311."

Deputy Coordinator Ralph K. Davies called attention to the fact that in addition to Form PD-311, foreign operators should be familiar with the provisions of Preference Rating Order P-98-d and Priorities Regulation 9, as amended, both of which were issued by WPB on October 1 and make the use of PD-311 forms mandatory.

In conjunction with the filing of Form PD-311, operators also were advised to refer to the Board of Economic Warfare for the correct "Export Program License Procedure," which was revised on October 20.

# Specifications for Petroleum Products

Minimum specifications on four principal petroleum products, which will be pooled and shipped into the East Coast area (District 1), have been set by the Office of Petroleum Coordinator, after consultation with the oil industry, Petroleum Coordinator for War Harold L. Ickes has announced.

These specifications for gasoline, kerosine, distillate, and residual fuel oils were set in accordance with OPC Directive No. 59, which provides for war-time pooling of petroleum products and terminal facilities on the Atlantic Seaboard. Refiners were notified of the requirements by letter from OPC. None of these specifications should cause any refiner or consumer undue hardship, Coordinator Ickes stated.

Minimum gasoline specifications call for 80-octane (American Society for Testing Materials specification) for premium, and 72-octane (A.S.T.M.) for regular or house brand. An 80-octane gasoline is necessary to meet Army requirements, Deputy Coordinator Ralph K. Davies explained.

The minimum specification for kerosine has been set in accordance with standards of the United States Treasury's Procurement Division, which buys for the Army and Navy. This specification (VV-K-211a) is generally known as standard, Davies said.

To assure all fuel oil consumers, as well as oil companies pooling their fuel oil, a product free from acid, grit, fibrous, or other foreign matter, OPC and the industry have adopted the specification of Commercial Standard CS12-40. This specification was set up by the industry several years ago, and is the basis used in preparing all fuel oil specifications, including those used by the U. S. Treasury Procurement Division for Army and Navy purchases.

"In setting up these specifications," Davies said, "it was the aim of this office and the industry to set minimum specifications which would cause the least hardship all around. We believe this goal has been achieved."

In a statement to the petroleum industry, establishing the minimum specifications, OPC pointed out that the specifications apply only to products imported into or produced in the eastern states pursuant to the provisions of Directive 59. Nothing therein shall require any change or action in conflict with any Federal, State, or local law, or any directive of any Federal War Agency, "or waive any provision of any other specification not inconsistent herewith, or apply to any principal petroleum products of a different specification ordered by the U. S. Army, Navy, Maritime Commission or Office of Lend-Lease Administration."

# Lima Field Crude Oil Prices Adjusted

Price adjustments on much of the crude petroleum produced in the Lima oil field of northwestern Ohio and northeastern Indiana were granted October 28 by the Office of Price Administration to halt premature abandonment of the wells and thus insure continued supply of low-cost fuel oil produced from this crude.

The price of approximately three quarters of the field's production was increased 25 cents a bbl.

The action was taken in Amendment No. 37 to Revised Price Schedule 88 (Petroleum and Petroleum Products) effective November 2.

Information in the possession of OPA indicated that the cost of producing the crude is substantially equal to the maximum price of $1.50 established by the amendment. Undue abandonment of wells in the field before they are exhausted is already taking place, OPA said. Substantial amounts of the crude are being used without processing as fuel oil by industries directly engaged in the war production, and loss or diminution of the supply would force the use of more expensive fuel.

There were two posted prices for the field on October 1, 1942, base period under the schedule, one for $1.25 per bbl. and one for $1.60 per bbl. The $1.25 price, which applied to about three fourths of the production, was increased to $1.50 by the amendment.

# Curtailment of Delivery of Paratone

The curtailment of all non-essential deliveries of the lubricating oil additive known as Paratone, until reserve stocks are built up to 100,000 gal., is recommended by the Office of Petroleum Coordinator for War Harold L. Ickes. The restriction is provided by the Coordinator's Recommendation No. 55.

Until this reserve supply reaches the 100,000-gal. level, Paratone deliveries are to be made only to persons using this additive in the production of aviation lubricating oil, recoil oil, or hydraulic oil, Deputy Coordinator Ralph K. Davies said

Persons accepting deliveries must certify that this additive is being used in accordance with the provisions of the recommendation controlling use and delivery of Paratone.

After the satisfactory reserve level has been reached, Paratone deliveries may be made as usual, provided such deliveries are not made from the reserve supply, Davies explained.

# Ask Increased Output of Coke

To increase the production of raw petroleum coke, approximately 30 refineries are being called upon to raise their output of this product, Petroleum Coordinator for War Harold L. Ickes has announced.

Raw petroleum coke is used for the manufacture of electrodes and other critical materials needed for the production of aluminum and other vital products, it was explained by Deputy Coordinator Ralph K. Davies.

The action to increase coke production was taken in OPC Recommendation No. 56, which states that the current deficiency in raw coke production can be partly corrected "by the fullest capacity operation of existing coking facilities in certain refineries best adapted to the production of such coke from the standpoints of availability of raw materials, character of equipment and operation, accessibility to transportation and effect on the production of war products."

Each of the refineries is directed to "eliminate or reduce the use, if any, of caustic soda or lime in connection with the production of such coke to the greatest extent possible without causing undue corrosion of the physical equipment."

Owners of the scheduled refineries presently covered by this recommendation are:

Cities Service Oil Company, Sinclair Refining Company, Gulf Oil Corporation, Shell Oil Company, Inc., Standard Oil Company of Indiana, Standard Oil Company of Ohio, The Texas Company, Kendall Refining Company, Utah Oil Refining Company, Union Oil Company of California, Magnolia Petroleum Company, Socony-Vacuum Oil Company, Inc., and Continental Oil Company.

# Utility Electric Power

## KEEPS OIL FLOWING FOR *VICTORY!*

Motor konk-out is still a costly hazard to aviation. Failure of engines to function can destroy life, man hours and money.

Likewise, power equipment that fails to perform efficiently at this time can also be responsible for destroying life and wasting man hours and money.

It is vitally important, then, to keep your power equipment in perfect condition, for much of the production and refining and transportation of oil depends on Utility Electric Power.

Proper maintenance of motors will avoid untimely breakdowns and replacements. It will also help keep oil flowing for Victory. Keep your motors running and production UP to Victory requirements!

## ELECTRIC MOTOR INSPECTION SCHEDULE

### EVERY WEEK

1. Examine commutator and brushes
2. Check oil level in bearings
3. See that oil rings turn with shaft
4. See that shaft is free of oil and grease from bearings—Keep oil where it belongs
5. Examine starter, switch, fuses, and other controls
6. Start motor and see that it is brought up to speed in normal time.

### EVERY SIX MONTHS

1. Clean motor thoroughly, blowing out dirt from windings and wipe commutator and brushes
2. Check brushes and renew any that are more than half worn
3. Examine brush holders and clean them if dirty. Make sure that brushes ride free in the holders
4. Check brush pressure
5. Drain, wash out, and renew oil in sleeve bearings
6. Check grease in ball or roller bearings
7. See that end play of shaft is normal
8. Inspect and tighten connections on motor and control
9. Check current input and compare with normal
10. Check motor foot bolts, end-shield bolts, pulley, coupling, gear and journal setscrews, and keys.

### ONCE A YEAR

1. Clean out and renew grease in ball or roller bearing housings
2. Test insulation by megger
3. Check air gap
4. Clean out magnetic dirt that may be hanging on poles
5. Clean out undercut slots in commutator
6. Examine connections of commutator and armature coils
7. Inspect armature bands.

## *Use Utility Electric Power!*

**PETROLEUM ELECTRIC POWER ASSOCIATION**

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SPECIFICATION
PROBLEMS

Physical and chemical research analyses, always a necessity, are now vital in supplying special war products.

Saybolt Laboratories are designed to substantiate and supplement the presently overtaxed operating facilities of the industry.

Your problems involving analytical research of petroleum, natural gases, and their products, will be given our careful attention.

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## Ideco Announces Promotions

Marcus T. McGriff was recently appointed manager of stores and sales of the Supply Store Department of International Derrick and Equipment Division of International-Stacey Corporation, Columbus, Ohio. McGriff joined Ideco four years ago to organize the department and has been active in developing this branch of Ideco's business.

McGriff is a native of Alabama and received his education in Alabama and North Carolina. He selected accounting as his special training and after graduation practiced this profession for several years—specializing in tax work and business organization.

McGriff has been a resident of Shreveport, Louisiana, for 15 years. From 1928 to 1932 was spent with Peden Iron and Steel Company's oil-well supply department. After leaving Peden, he operated as a manufacturer's agent for several large manufacturing firms until his affiliation with Ideco. He will continue to make his headquarters in Shreveport.

C. M. Powell has been appointed manager of oil-field equipment for International Derrick and Equipment Company.

A native Texan, born near Decatur, Powell completed his business education in Dallas. After serving with armed forces in World War I, he became interested in the oil-well equipment business and was closely associated with many of the early boom fields of Texas.

Joining the Ideco organization in 1925 as district manager of Oklahoma, Powell was division manager of Oklahoma, Kansas, Illinois, and Indiana at the time of his new appointment. Before his connection with Ideco, he was assistant sales manager of the Bridgeport Machine Company of Wichita, Kansas, and district manager for Black, Sivalls and Bryson, Inc., working out of Wichita Falls, Texas. He now resides at Tulsa, Oklahoma, and will continue to make that his headquarters.

## Herrington Director of Aviation Corporation

Tom Girdler's place on the directorate of The Aviation Corporation has been taken by A. W. Herrington, board chairman of Marmon-Herrington Company, Indianapolis, Indiana, while Girdler will devote his time chiefly to the operation of Consolidated, and Vultee Aircraft, both of which are Aviation Corporation affiliates. Girdler will still be available to the parent corporation, for consultation.


END *your*
FLEXIBLE LINE
PROBLEMS *for*
*the duration!*

Avoid costly shut-downs for repairs due to dangerous leaks or failure of weakened hose lines. Install CHIKSAN Ball-Bearing Swing Joints NOW and solve your flexible line problems not only for the duration but for years to come.

Style 60 Chiksan High Temperature Swing Joint for temperatures to 700° F. and 500 lbs. pressure. One of over 500 different Types, Styles and Sizes.

**CHIKSAN SWING JOINTS FOR HANDLING SYNTHETIC RUBBER PRODUCTION MATERIALS**

CHIKSAN Swing Joints handle butadiene, butylenes, propylenes, sulphate cyanide, ethylene, aromatics, alcohols, toluene, propane, butane, black liquor, gasoline, acids, alkalies. Special packing to handle your particular needs.

**OVER 500 DIFFERENT TYPES, STYLES, SIZES FOR EVERY PETROLEUM INDUSTRY USE**

CHIKSAN Ball-Bearing Swing Joints give full 360° rotation in 1, 2 and 3 planes. Made in sizes from 3/8" to 12"; larger sizes to order. For all services from vacuum to 3000 lbs. working pressure. High Temperature Joints for 500 lbs. working pressure, 700° F. End connections: threaded, flanged or bored for welding.

CHIKSAN TOOL COMPANY
CHIKSAN
BALL BEARING SWING JOINTS for ALL PURPOSES
BREA, CALIFORNIA
ALL-STEEL ROTARY HOSE
CIRCULATING HEADS · MUD GUNS

## New Post for Earl Wesselhoff

Walter Bertram, sales manager of Morse Chain Company, Ithaca, New York, announces the appointment of Earl Wesselhoff as manager of the Boston Branch to succeed C. L. Pratt, Jr., who has resigned.

Wesselhoff goes to the Boston Branch from the Detroit plant where his first association with the company began 22 years ago as automotive timing chain drive engineer. He had much to do with the early development and application of silent automotive timing chain drives. Since he joined Morse

EARL WESSELHOFF

he has served in several engineering capacities and was subsequently promoted to the dual position of chief engineer plus the sales directorship of the Morse Indexing and Free-Wheeling Clutch lines. He has had a long and extended career in the industrial power transmission field.

For several years Wesselhoff has been identified with many engineering improvements in the Morse line of Indexing and Free-Wheeling Clutches. He performed noteworthy engineering in pioneering the development of practical dual-drive hook-ups involving combinations of prime movers such as turbines, electric motors, and engines for driving centrifugal water pumps and forced- and induced-draft fans etc. He also achieved success in working out practical principles and applications for utilizing standardized, high-speed gas and Diesel engines by efficiently harnessing and automatically controlling them through multiple hook-ups of from one to twelve engines to produce a single source of dependable and economical power.

In the new post, Wesselhoff will make his quarters in Boston, from which he will service Morse Chain Company accounts throughout the New England States in a sales, engineering, and service capacity.

*With an* **OTIS**

**REMOVABLE BOTTOM HOLE REGULATOR**

Production shutdowns due to freezing surface connections are absolutely eliminated with an OTIS Removable Bottom Hole Regulator.

By placing the point of principal pressure reduction at a Sub-Surface depth, the tubing acts as a "mile long heater" with the high Sub-Surface temperatures completely absorbing all temperature losses due to gas expansion.

The rate of flow is controlled by the surface choke—the openings in the regulator change automatically to allow the desired rate.

The OTIS Bottom Hole Regulator is run and pulled under pressure on an ordinary steel measuring line.

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DALLAS, TEXAS

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*Representatives:* Otis Eastern Service, Inc. Wellsville, New York; Western Pressure Control, Los Angeles and Bakersfield, California

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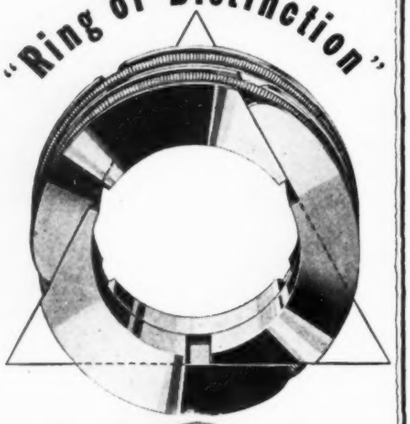
"Ring of Distinction"



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Original FRANCE METAL PACKING

## Los Angeles Nomads Honor Charter Members

The first fall meeting of the Los Angeles Chapter of Nomads, held at the Clark Hotel October 21, 1942, was in honor of the charter members. After calling the roll of the charter members and having each present rise, short talks were given by the three past presidents of the organization. Elmer Decker, the first president of the chapter, spoke first and was followed by Ted Sutter, the second president, and Ernie Fowks, the third president. Bill Bettis, the present and fourth president, then introduced the speaker of the evening, Dick Atkinson.

Atkinson spoke on Russia and, after giving a background of developments in that country since the First World War, stated that he felt confident of the ability of Russia to withstand the German attack. He based his remarks on his familiarity with Russia and the Russian people. Atkinson first went to Russia during the previous war and was in close contact with both the fighting forces and the powers that were. He was there during the period of revolution and obtained first-hand knowledge of Lenin, Trotsky, and Stalin.

Since the hectic time of his first visit Atkinson has made several more trips to Russia. During the period between the previous war and the present conflict he has become impressed with the advancement of the people in education, medicine, engineering, and the arts. He firmly believes that the Russian people have a sincere feeling of friendship for America and admire particularly our industrial development.

Among oil men from foreign fields present at the meeting were Karl Jauman, formerly with the Antilles Petroleum Company in Trinidad; E. B. Udlock of the Standard Oil Company of Venezuela; D. W. Patton of the Columbian Petroleum Company; Alfonso Chiriboga who is with the Department of Mines and Oil of the Ecuadorian Government; William Porter, a consulting geologist who spent some time in the Philippines before the present war, and R. H. Larson of Balfour, Guthrie and Company, whose foreign interests are well known.

## Oversubscribe War Bond Drive Quota

Stanley E. Johnson, assistant sales manager of The Cooper-Bessemer Corporation, Mount Vernon, Ohio, manufacturers of Diesel and gas engines and compressors, can hardly believe he isn't dreaming.

On September 29, Johnson, in co-

In the creation of the four freedoms composing the Atlantic Charter our leaders crystallize into a working ideal the true philosophy of free people ... people not downed by territorial boundaries, but people that carry their nationalism wherever they are or wherever they are forced to go.

How can such a spirit be conquered? Lands may be conquered ... people eliminated ... cities wiped out ... but the spirit of freedom lives as long as those who breathe it live.

That these four freedoms are worth fighting for requires but a glance in the direction of those people who for the moment feel their loss. We here are resolved that

*They Shall Not Pass!*

★

ALABAMA
Hotel Admiral Semmes ..... Mobile
Hotel Thomas Jefferson ..... Birmingham

DISTRICT OF COLUMBIA
Hotel Washington ..... Washington

ILLINOIS
Hotel Faust ..... Rockford

LOUISIANA
Jung Hotel ..... New Orleans
Hotel DeSoto ..... New Orleans

MISSISSIPPI
Hotel Lamar ..... Meridian

NEBRASKA
Hotel Paxton ..... Omaha

NEW MEXICO
Hotel Clovis ..... Clovis

OKLAHOMA
Oklahoma Biltmore ..... Oklahoma City
Hotel Aldridge ..... Wewoka

SOUTH CAROLINA
Hotel Wade Hampton ..... Columbia

TEXAS
Hotel Alice ..... Alice
Hotel Stephen F. Austin ..... Austin
Hotel Edson ..... Beaumont
Hotel Settles ..... Big Spring
Hotel Brownwood ..... Brownwood
Hotel Southern ..... Brownwood
Hotel Laguna ..... Cisco
Hotel Cortez ..... El Paso
Hotel Texas ..... Fort Worth
Hotel Buccaneer ..... Galveston
Hotel Jean LaFitte ..... Galveston
Coronado Courts ..... Galveston
Jack Tar Court ..... Galveston
Miramar Court ..... Galveston
Hotel Cavalier ..... Galveston
Hotel Plaza ..... Laredo
Hotel Lubbock ..... Lubbock
Hotel Falls ..... Marlin
Hotel Cactus ..... San Angelo
Angeles Courts ..... San Antonio

VIRGINIA
Mountain Lake Hotel ..... Mountain Lake

We've joined up!
HOTEL GALVEZ . . . Galveston, Texas
Now used exclusively by U. S. Coast Guard.
No guests taken 'til Victory has been won.

Affiliated NATIONAL HOTELS
HOST TO THE NATION
SERVING 10 STATES AND OUR NATION'S CAPITAL

operation with local officials and civic leaders, directed a one-day War Bond Drive in Mount Vernon with the hope of collecting $100,000 from the 30,000 residents of the city and the rest of Knox County. That would have been more than $3 for every man, woman, and child in the entire area.

To assure success, he made September 29, a day to be remembered in Mount Vernon history. Everyone dropped anything else he might be doing to watch or take part in one of the most spectacular drives ever conducted in the state.

As a result, the $100,000 goal was not only realized within a few hours, but for the day, Johnson counted a total of $350,855 in bond purchases and subscriptions. The figure is still going up. The present total actually represents more than $11 for every resident in the county.

The Cooper-Bessemer official did not overlook a single possibility in organizing the Knox County Victory Bond Day on September 29. Interesting events took place in steady succession throughout the day.

The whole city hung out bunting, flags, and other decorations. Crowds gathered early in the morning at Victory Square.

The events started at 10 a. m. when at the sound of air-raid sirens everyone in the city was asked to rise and stand quietly with bowed heads for two minutes. At that moment the Rev. Alex Hawks, rector of St. Paul's Episcopal Church, pronounced an invocation at the square. There was not an idle moment from then on until nearly midnight.

There was speech making, musical entertainment, a beauty contest, demonstration of U. S. Army jeeps, dropping of "bombs" from planes, auctioning of cattle, "Sock-a-dictator" ball throwing contest, street dancing, and refreshments.

The ball was started rolling in the bond drive several weeks previously by The Cooper-Bessemer Corporation, Mount Vernon's largest industry which also has a plant in Grove City, Pennsylvania. On August 29, the firm received the United States Treasury's Minute Man Flag for subscribing 10 percent of its payroll for War Bonds. Every official and employee in the Mount Vernon Plant subscribed.

The corporation is manufacturing engines for the United States Navy and the Maritime Commission, and compressors for vital war industries. One of the country's oldest engine manufacturers, it has been in business 109 years.


# AVOID this Costly Valve Leakage

| AREA OF LEAK | AIR | | STEAM | | WATER | |
|---|---|---|---|---|---|---|
| Diameter Inches | Number of cubic feet per month at 75 lb. pressure | Total cost of waste per month 11c per 1000 cubic feet | Pounds wasted per month at 160 lb. pressure | Total cost of waste per month 65c per 1000 lb. | Gallons wasted per month at 60 lb. pressure | Total cost of waste per month 16c per 1000 gallons |
| 1/2" | 13,468,000 | $1,481.44 | 1,219,280 | $792.53 | 1,524,100 | $243.86 |
| 3/8" | 7,558,500 | 831.44 | 684,290 | 444.79 | 855,360 | 136.86 |
| 1/4" | 3,366,990 | 370.37 | 304,820 | 198.13 | 381,020 | 60.96 |
| 1/8" | 824,570 | 90.70 | 74,650 | 48.52 | 93,310 | 14.93 |
| 1/16" | 213,000 | 23.43 | 19,280 | 12.53 | 24,110 | 3.80 |
| 1/32" | 52,910 | 5.82 | 4,790 | 3.11 | 5,990 | .96 |

Enlarged copies of this chart available on request; also Lunkenheimer Catalog 78.

Valves aren't so easy to replace these days . . . practically all materials going into their manufacture are on the critical list. This means that it is up to every valve user to take the best care of what he has to insure the longest possible service life.

Leaky valves are saboteurs of your production schedules . . . obstructing your best efforts and increasing your costs. The chart illustrated above gives you an idea of what valve leakage costs you.

Fortunately, valves respond to good treatment. Careful handling, immediate repair of the slightest leaks, and prompt replacements of worn parts will keep them on the job, ready to meet the demands imposed by industry's unprecedented war effort.

Since virtually all materials used in the manufacture of valves are on the list of critical materials, valve users are urged to furnish the highest possible preference ratings and proper "end use" symbols on their orders. This will be of mutual helpfulness.

ESTABLISHED 1862

THE LUNKENHEIMER CO.

"QUALITY"

CINCINNATI, OHIO, U. S. A.

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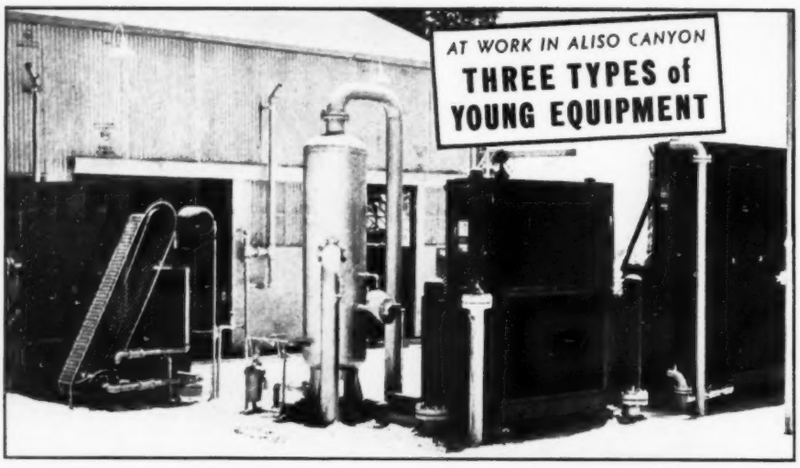
LUNKENHEIMER VALVES




That YOUNG equipment will handle a wide range of oil field requirements and do it at a substantial saving is well illustrated by this unusual installation. Three different types of YOUNG heat transfer units serve a 300 H.P., 2 stage natural gas compressor with a 2,000,000 cu. ft. twenty-four hour capacity. The YOUNG FULL-FLOW Engine Jacket Water Cooler (extreme right) cools engine and compressor jacket water. The YOUNG Gas Cooler (center) consists of two coil sections to cool the gas through both stages of compression. A YOUNG Evaporative Cooler (left) cools the gas from an atmospheric to a wet bulb temperature. Write for catalogs and engineering data.

**YOUNG RADIATOR COMPANY — Dept. 282-L, Racine, Wis., U.S.A.**
*Mid-Continent Distributor* — **THE HAPPY CO., Tulsa, Okla.**
*Pacific Coast Distributor* — **A. R. FLOURNOY, Bell, Calif.**

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OIL COOLERS • GAS, GASOLINE, DIESEL ENGINE COOLING RADIATORS • INTERCOOLERS • HEAT EXCHANGERS • ENGINE JACKET WATER COOLERS • UNIT HEATERS • CONVECTORS • CONDENSORS • EVAPORATORS • AIR CONDITIONING UNITS • HEATING COILS • COOLING COILS

Young SERVICE

**SPECIFY VORTOX TO COMPLETE YOUR ENGINE MAINTENANCE PROGRAM**

Today you're doing everything necessary to make your oil field engines last as long as possible—because many of them can't be replaced until the War is won.

And if you haven't been using air cleaners on your equipment, you can effectively cut engine wear and reduce replacement needs by installing them *now*. Just make sure they're *Vortox Cleaners!* These Cleaners have PLUS FEATURES you can't afford to be without . . .

Unusually high dust *removing* and dust *holding* capacities.

Oil-washed filters designed to prevent build-up of restricted air flow, do not require frequent cleaning or replacement.

Simple, trouble-free maintenance—just change oil when necessary, to remove all trapped dirt. Peak efficiency over exceptionally long periods.

Get the full facts about Vortox Air Cleaners today. Find out why Vortox-equipped engines are running longer between overhauls . . . operating more efficiently . . . cutting new part requirements. Made in sizes and types for every installation requirement.

**VORTOX MANUFACTURING CO.**
CLAREMONT, CALIFORNIA

**VORTOX OIL TYPE SELF-WASHING AIR CLEANER**


## G. E. Clifford Elected Vice-President National Supply

George E. Clifford was elected a vice-president of The National Supply Company, Pittsburgh, Pennsylvania,

GEORGE E. CLIFFORD

effective as of October 19, 1942. Clifford will supervise the sales of certain munitions, in addition to his present responsibilities as vice-president in charge of sales for Spang Chalfant, Inc.

## Maintaining Equipment Stressed in Publication

Keeping all kinds of present equipment in proper repair is not merely a patriotic duty these days. It is one of the requirements that must be done if we are to win the war in the shortest possible time. This fact is aptly expressed in *Cletrac Facts*, publication of The Cleveland Tractor Company, Cleveland, Ohio.

To assist Cletrac dealers in their efforts to "Keep 'em Rolling," the second issue of *Cletrac Facts* features five practical suggestions for maintaining Cletracs in productive service.

One suggestion explains how worn lower track wheel shafts can be restored in approximately 3 hours by building them up through welding—then grinding them down to their original diameter. Another describes the methods used to rebuild Model F grousers by cutting, then welding lengths of stock to the worn grousers. A third illustrates how Diesel lower track wheels—worn to a taper—can be built up with from 3 to 5 lb. of electrode, then the face ground down to proper size. The fourth and fifth suggestions concern methods of rehabilitating FD lower track wheels by restoring the bead on wheels, using a home-made support to speed up the work; and, how drive sprockets can be built up to their original contour.

## Oilwell Moves L. H. Keim to Oil City

Oil Well Supply Company has announced the transfer of L. H. Keim, vice-president in charge of its West Coast operations, to the company's manufacturing headquarters at Oil City, Pennsylvania.

The increased war production activities in Oilwell's plants require the addition of executive personnel for the duration, and Keim's background and experience in manufacturing and field service will be particularly valuable to the company's plant operations in the present war effort.

L. H. KEIM

Keim is a native of Pittsburgh, Pennsylvania, where he received his technical and practical training.

In 1912 he became affiliated with the Westinghouse interests with various assignments, including that of mechanical engineer. During the first World War, Keim assisted in designing and producing tanks and heavy ordnance, and, after the Armistice, was appointed general sales manager of the Nuttall Division.

Nuttall and Oilwell collaborated in the design and development of special drilling equipment, after which Keim joined the Oilwell organization and was transferred to California. He was appointed general manager in charge of sales and manufacturing operations, and, since 1929, has served as vice-president.

## Tulsa Nomads Meet

The regular monthly meeting of the Tulsa Chapter Nomads was held Monday, October 26, at the Tulsa Club. The speaker for the occasion was Gerald H. Westby of the Seismograph Service Corporation, who had as his subject "The Petroleum Industry and the Civil Air Patrol." Westby has been engaged in air patrol service since the United States entered the war and gave some interesting details of this work.

CURTIN CENTRIFUGES

Give You Quick, Accurate Results With LESS EFFORT . . . at LESS COST

Simple in design, ruggedly built for heavy duty service. Gear ratio and throw of crank produce required speed with no strain. Heads and cranks of 100 CC and 15 CC machines are interchangeable. **Meets A.S.T.M. Standard Method D-96 and A.P.I. Code No. 25 requirements.**

*Ask for full details.*

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Dependable Protection . . .

Against RUST ✓
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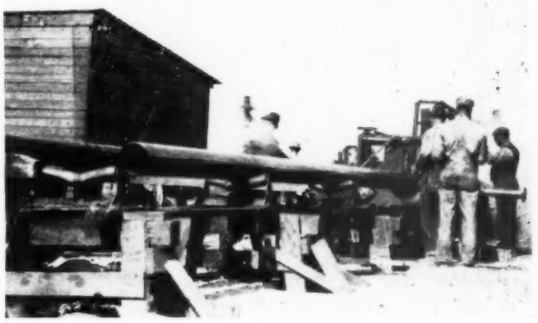

REILLY PIPE ENAMEL

Reilly COAL TAR PRODUCTS

Pipe lines coated with REILLY ENAMEL give long and dependable service and low maintenance costs in all types of soil and under wide extremes of temperature. The tough, durable REILLY coating effectually prevents corrosion from moisture, electrolysis, soil acids and alkalies; resists abrasion and soil stress, and will not crack in sub-zero cold or sag in tropical heat. . . . As an inner lining on water mains, REILLY ENAMEL protects against incrustations and tuberculation and assures full-capacity flow for the life of the pipe. . . . On storage tanks, structural steel work and other metal surfaces REILLY Coal Tar Paints give effective, economical protection against corrosive vapors and gases.

*Booklet describing* REILLY *Protective Coatings will be sent on request.*

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## The Mileage Rationing Program

The Office of Petroleum Administration has issued the following questions and answers on mileage rationing that will be of interest to those in the petroleum industry as well as those in all industrial fields:

Q. Why is the new plan for rationing gasoline and tires called a mileage rationing program?

A. Because the object is to save rubber by reducing car mileage to the 5000-mile a year national average recommended by the Baruch Committee.

Q. Does this mean that every car owner gets to drive 5000 miles annually?

A. Absolutely not. Owners of registered passenger automobiles, with some few exceptions, are entitled to a basic ration which provides for 2880 miles a year. Each owner will get more mileage only if he shows occupational need for it.

Q. Then, no one will drive more than 5000 miles a year?

A. That's not necessarily true, either. Five thousand miles a year is the national average to be achieved under mileage rationing. Cars used for purposes regarded as essential to the war effort may qualify for more than 5000 miles a year upon proof of need.

Q. What specific purposes are regarded as most essential to the war effort?

A. The gasoline rationing regulations will list 20 car and motorcycle uses for which preferred mileage will be allowed. These include such uses as transporting workers to and from jobs in war production plants, carrying doctors on professional calls, taking farm produce to market and bringing back farm supplies.

Q. What is preferred mileage?

A. It is mileage above 470 miles a month. Only drivers in the preferred class can get it.

Q. Is this the C ration class?

A. Yes.

Q. What about drivers who aren't on that list?

A. They may get a basic A book. They may also get a B book, if they can show occupational need and meet the car sharing requirements.

Q. Then what mileage may the ordinary occupational driver qualify for through the A and B books?

A. Up to 470 miles a month for occupational driving.

Q. Do persons who use their cars in driving to work, or in connection with their jobs automatically get supplemental rations through a B or a C book if ride-sharing or other requirements of the Regulations are satisfied

A. No. Only when they prove need for more than the basic A book provides.

Q. How much is this?

A. The A book provides gasoline for a total of 240 miles a month. Of this mileage 90 miles may be reserved for essential family driving, such as taking the children to school, or a sick person to the hospital. The remaining 150 miles is deemed to be available for occupational use.

Q. How are motorists going to get their mileage rations?

A. By getting an application form, filling it out and presenting it to a schoolhouse registrar, who will issue the basic A book. Applications for supplemental rations must be presented later to a local War Price and Rationing Board.

Q. Will owners of motorcycles also follow this procedure?

A. Yes. But they will be issued basic D books.

Q. When and where can I get an application form for the basic ration?

A. These blanks may be picked up at service stations, garages, and other conveniently located places which will be announced. The dates on which they will be available will be announced locally.

Q. When will registration at the school houses take place?

A. Beginning November 20. In most localities the registration period will extend over a period of three days, but the time may be adjusted to meet local requirements.

Q. I get my A book at that time. Then what happens?

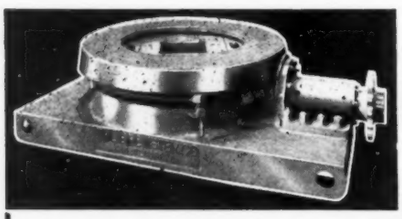
A. Hold the A book for use when rationing goes into effect on December 1. While at the school house, ask for a supplemental application blank if you think you will need more gasoline than the basic book will provide for occupational purposes.

Q. So I get my gasoline ration. What about tires?

A. The government will do its best to supply you with tires or recaps to cover the mileage permitted by the gasoline ration. But you will have to meet certain obligations.

Q. What's the hitch?

A. No hitch. Just remember that Uncle Sam has a very limited supply of rubber on hand, and he can't get much more for a while. And when he talks about "supply

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So Uncle Sam wants oil! All right, we're ready with 18", 22" and 26" Brewster Oilbath Rotaries, tough as a boot, simplified, streamlined and fully enclosed.

The 26" job gives you a rated supportable load capacity of 265.5 tons at 100 R.P.M. Good for any depth to 15,000'. See current Composite Catalog.

★ Waterproof, slushproof table.

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Top that 10% War Bond buying by New Year's . . We are already on the Honor Roll here at BREWSTER'S

on hand" he includes the millions of pounds of rubber running on the Nation's automobile wheels right now. You've got to help conserve it.

Q. Sure, I'll help. But how?

A. By taking good care of your tires, by driving carefully, never more than 35 miles an hour. You will help also by having your tires inspected regularly, and turning in to the Government all tires you or relations living with you own in excess of those mounted (including one spare per motor vehicle) on motor vehicles or equipment. Certain tires owned by the tire dealers and manufacturers are not to be included in this computation.

Q. That's fine, but what have all these things to do with mileage rationing?

A. You have to do them to get your ration of gasoline, and maintain your right to use such rations and to have them renewed.

Q. Let's start from the beginning. What do I do first about my tires?

A. First, list the serial numbers of every tire which you own or which any relations living in your household owns.

Q. I found several sets of numbers on these tires. Which is the right one?

A. The serial numbers are always indented on the wall of the tire. The other numbers or letters are raised.

Q. I can't find any indented numbers. They must have been worn off, or rubbed out.

A. In that case you need only the brand name of the tire.

Q. I have listed all my tire serial numbers. Now what do I do with them?

A. On the back of the application blank for the basic mileage ration, you will find space to write these numbers down.

Q. Do I have to do this?

A. It's necessary, if you hope to get a mileage ration.

Q. Do I list all my tires, or just five?

A. You must list all passenger car tires that you own and all that are owned by any relative living at your house.

Q. I own only one automobile, no other motor vehicle, trailer, or other equipment on which passenger tires might be used. I own and list eight tires. What happens?

A. The registrar will not issue you a ration. You have to dispose of those three excess tires first. Call up your nearest Railway Express Agency. They will send some one around to pick up the tires, and arrange to have the Government pay you for them if you wish.

Q. What happens after I list the five tires I am keeping for my car, and the registrar issues me my basic book?

A. The registrar also will give you that part of the application blank which contains the Tire Inspection Record.

Q. I've got to hang on to that?

A. Yes, it's a valuable piece of paper. It will be a record of your periodic tire inspections, and will be proof later on that you've taken good care of your tires.

Q. How soon will the first inspection have to take place?

A. Between December 1, 1942, and January 31, 1943. (Date possibly will be changed.)

Q. Where can I get a tire inspection?

A. At any service station, tire shop, or garage authorized by OPA to perform the inspection.

Q. How often will these inspections be required?

A. Holders of B and C rations must get inspections every 60 days. Holders of only A or Basic D books need get an inspection only once in every four months.

Q. Can the owner of a trailer keep tires for the wheels of that vehicle?

A. Yes. He may keep one tire for each wheel of the vehicle.

Q. Will the owner of a house trailer be permitted a spare for that trailer?

A. No.

Q. What about extra tubes? Must they be turned in to the Government, too?

A. No. But the Government urges you to turn in excess tubes.

Q. Where application is made for a mileage ration to be used for trucks and taxis, must excess tires be turned in?

A. No. But all must be reported when the vehicle is registered for a mileage ration.

Q. When do I get a new tire?

A. Your tire inspector will inform you when one of your tires is in need for a replacement. He will certify this fact to your local War Price and Rationing Board.

Q. Do I apply then to the Board for a new tire or a recap?

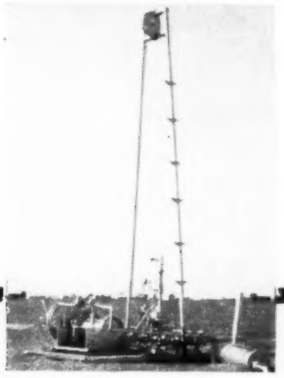
A. Yes.

Q. Will a tire or a recap be issued to me at that time?

A. If your tire inspection record is up-to-date, if it shows you have not abused your tires, if you have abided by the 35-mile-an-hour speed limit, if you have not otherwise violated either the tire or the gasoline rationing regulations, the Board may issue you a certificate for a certain grade of tire or for a recap.

Q. What kind of tire or recap will be made available to me?

A. That depends on the type of mileage ration book you hold, and the use you make of your car. Because of the war emergency, the idea is to give no one a better grade of tire, or more rubber than he needs.

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*Gas-Lift*
**SYSTEM**

*Pounds—Not Tons—of equipment for Oil Production*

When you install a Nixon Gas-Lift System on your wells you are aiding the war effort.

There are only a few pounds of metal in the Nixon Gas-Lift System, as compared with tons required by standard pumping rigs. Power, too, is saved, because it operates on cheap gas pressure. It also saves manpower and transportation.

With this efficient System you can produce large or small volumes from your wells with utmost economy. Any change in production from restricted allowables to the well's maximum flow volume, can be done without disturbing the well setting or the use of additional equipment.

A Nixon Gas-lift Engineer can show you how to economize on your production and well problems. Write your nearest Wilson Supply Company store or sales office.

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TRINIDAD, B.W.I.: Neal Massey Engineering Corporation

BRANCH STORES:

TEXAS—Gladewater, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi.
LOUISIANA—Lake Charles, New Iberia, Harvey, Shreveport.

Q. According to present plans I expect to have my car away from home on December 1 when rationing goes into effect. Will I be able to get a gasoline ration to drive home after that date?

A. While all travel must be reduced to a minimum if we are to provide tires or recaps for essential driving, autoists who are caught away from home when rationing goes into effect will be eligible for a special ration to get their cars home.

Q. Will this apply to motorists of the Eastern rationed area?

A. Yes, if they have their cars outside the Eastern rationed area on December 1. But, if any car owned by an Eastern motorist is at some other point in the Eastern area, it would not be eligible for a special ration to be driven home, unless it had been continuously away from that home since last August 22.

## Petroleum Men Prominent Among Awardees in Lincoln Foundation Welding Study

Petroleum men figured prominently in the awards announced in the nationwide 2½-year, $200,000 scientific welding study program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

The welding study, known as the "$200,000 Industrial Progress Award Program," brought forth reports of welding progress prepared by executives, engineers, designers, architects, production officials, and others throughout the industrial fields. The study indicated a possibility of tremendous savings in costs and man hours for production of products by arc welding for both war and peace.

"Savings in critical materials and in production costs," said Dr. E. E. Dreese, chairman of the Lincoln Foundation, and of its Jury of Award, "reported available by arc welding in the award studies, assume such proportions as to be of vital national significance.

"The figures, based on representative products and structures, show a possible annual cost savings of $1,825,000,000. This includes 7,000,000 tons of steel valued at $271,000,000 and 153,000,000 man hours of labor. This saving in man hours will place the industrial manufacturer in a strong position to compete in future world markets."

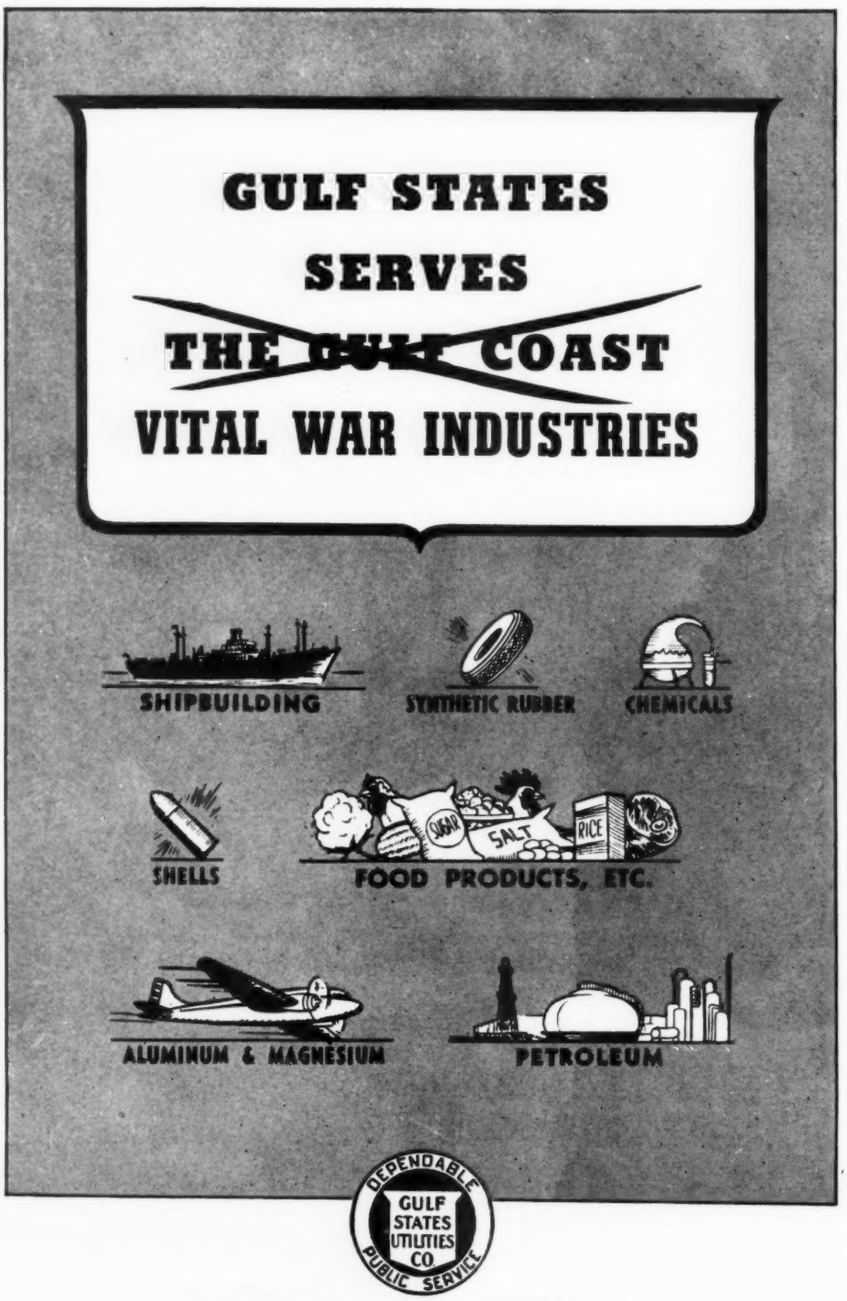
In the petroleum industry, some of the chief awards, the names, subjects, and connections of awardees are as follows:

W. W. McCLOW

$3700, W. W. McClow, assistant general maintenance foreman, The Pure Oil Company, Toledo Refinery, Toledo, Ohio. Subject matter: Corrosion control in refinery pressure vessels by means of arc-welded stainless steel lining. Economic advantages of extending the life of fractionating towers in gasoline refining by arc welding into these shells No. 12 BWG 12-14 percent chromium steel of 0.08 percent carbon. Steel strips are 4 in. wide, pickled and purchased on reels. Average cost per sq. ft. per year of stainless steel liner is $0.33 as compared with carbon steel lining at $2.48 or a granite lining at $2.16.

E. F. BRUMMERSTEDT

$700, Egon F. Brummerstedt, mechanical engineer, Petroleum Division, Foster Wheeler Corporation, New York, New York. Subject matter: The problems solved by the use of arc welding in the design and construction of a 33-ft. diameter vacuum-fractionating tower that is one of the largest individual units of equipment ever used in an oil refinery. Welding permitted the use of steel bubble trays instead of cast iron with a saving of 30 percent in the cost of trays and a considerable saving in load weight. Retail strength, size, weight, and welding calculations are given for all parts of this unit. The welded construction saved $36,860 as


General Offices—Beaumont, Texas, and Baton Rouge and Lake Charles, Louisiana

compared to a riveted unit and was erected in two months' less time.

R. M. CARTER

$500, Robert M. Carter, engineer, Line Maintenance Department, Stanolind Pipe Line Company, Tulsa, Oklahoma. Subject matter: A batching scraper for crude oil pipe lines designed for arc-welded construction. It is necessary that the refinery know what grade of crude oil is being supplied and when delivery from different areas is made through the same pipe. It is important that the two batches be properly separated with a minimum of mixing. Previous to the present design, pipeline scrapers were sent down the line for this purpose. The disadvantages of this were: inefficiency in separating batches, high maintenance cost as a result of wear and breakage due to jamming. This unit was replaced by a simple batching scraper that consisted mainly of two rubber disks mounted on a central body behind a guiding conical-shaped framework. Not only did this unit improve separation, it also reduced the cost and maintenance and improved pipe cleaning. A considerable saving because of less repairs and less waste oil is expected.

$250, R. W. Gladson, welder, Stanolind Pipe Line Company, Tulsa, Oklahoma. Subject matter: A housing for an electric motor to be used outdoors (in the oil fields) to protect motor from rain, snow, dust, etc. Made of sheet steel by arc welding. The first housings caused the motor to overheat and burn out. The new design consists of an outer and an inner housing. The two streams do not meet and mingle. Hence, motor turns cool. This housing can now be built for $155. Rivet construction would be at least one-third more. A waterproof motor supplied by manufacturing costs $1725 more than one not waterproof. Steel housing much cheaper and more substantial than wood.

## San Joaquin Valley Chapter A.P.I. Meets

The regular meeting of the San Joaquin Valley Chapter of the American Petroleum Institute was held at El Tejon Hotel, Bakersfield, on Tuesday, October 20.

The meeting was called to order by Chairman J. B. Wharton, with 75 members and guests present.

J. B. Stevens proposed that the number of meetings be changed from eight to five for 1943. Elmo Fulmer pointed out that any proposed change in the by-laws must be read at the meeting prior to that at which a vote is taken on the matter. Stevens then proposed the following amendment to the by-laws:

ARTICLE III—*Meetings*

Section 1. Regular meetings shall be held at 7:30 p. m. on the third Tuesdays of January, March, May, September, and November.

It was implied from the discussions that three meetings a year would be held in Taft and two in Bakersfield.

Charles Moore of the Office of Petroleum Coördinator read a request from R. P. Huggins, chairman of the Conservation Committee, asking that all operators be prompt in sending in reports to the committee.

Vice-chairman Suman announced the following program:

"The Part that Modern Oil Well Cementing Technique is Playing in Our War Effort" (Illustrated) by P. E. Hilton, Baker Oil Tools, Inc., Los Angeles.

"Interesting Side Trips from Northern Oil Fields of South America" (Colored Moving Pictures) by R. J. Eiche and T. G. Martin, Nomads of Los Angeles and Long Beach.

PUT "CLEVELANDS" ON YOUR WAR EMERGENCY PIPELINE JOBS—

*Whether It's:—*

Long Main Lines—Gathering Lines or Loops—"Hot-Spot" Reconditioning—Stripping Pipe for Reconditioning and Relaying—Short Scattered Field Lines or Ordinary Maintenance.

*In today's pipeline construction programs,* Speed, Endurance, Low Cost operation and Service are the most essential machine requirements. That's why "CLEVELANDS" fit so perfectly into the picture and are preferred equipment on so many war and civilian emergency projects, current and recent. Geared to the job "CLEVELANDS" are delivering maximum performance, day in and day out, at rock bottom costs.

THE CLEVELAND TRENCHER CO.
*"Pioneer of the Small Trencher"*
20100 ST. CLAIR AVE. • CLEVELAND, OHIO

"CLEVELANDS" Save More . . . Because they Do More

## McKissick Catalog On Blocks

The McKissick Products Corporation, Tulsa, Oklahoma, has just issued a most complete catalog on blocks as used in the petroleum industry. There are many illustrations of newly perfected blocks, although production is actually curtailed, as more than 90 percent of the facilities of this company are now devoted to requirements of the Army, Navy, and other defense industries.

From practical experience in the field, McKissick engineers have designed blocks having sufficient sheave utility, yet embodying compactness, safety, and durability to withstand hard oilfield treatment. Flexibility of application is also a prime object of the designs.

By following approved specifications with respect to sheave design and line grooving, blocks of great utility and satisfactory performance have been perfected in many classifications. The company holds a large number of patents, an indication of improvements in designs made by McKissick engineers.

The new catalog shows some of the developments that have occurred in block design during the last few years. Need for blocks of various sizes and for unusual applications necessitated the design and production of many types of blocks that will later be offered to a number of industries in addition to petroleum. Due to its background of successful service to the oil industry, McKissick has been called upon to design and produce many blocks required by various defense industries.

WEDGE GATE VALVES

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● COLMONOY alloys offer extreme resistance to galling, corrosion, "wire drawing," and abrasive grit. This unretouched photograph shows a 1/8 in. casting of COLMONOY, furnace welded to the wedge. COLMONOY greatly increases the life of wedge valves, in spite of high temperatures, extreme pressures, and severe operating conditions. The exceptionally high wear resistance of the hard surface of COLMONOY alloys will protect all vital wearing parts of your equipment. Mild steel parts coated with COLMONOY alloys wear from 3 to 10 times as long as new parts made of high alloy steel.

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COLMONOY

*Hard Surfacing Alloys and Overlay Metals*


## Prof. and Mrs. Ipatieff Honored

Professor Vladimir Nikolaevich Ipatieff and Mrs. Ipatieff were guests of honor at a banquet given by the Chicago Chapter of the American Institute of Chemists, on Friday, November 20, at the Adventurers Club, 14 North Michigan Avenue, Chicago.

Three important phases in the lives of this distinguished couple were celebrated: the 75th birthday of the professor; the Golden Jubilee of his career in chemistry, and their Golden Wedding anniversary.

Dr. Gustav Egloff, national president of the American Institute of Chemists, and director of research of Universal Oil Products Company, presided and introduced the chairman of the meeting, Dr. Vanderveer Voorhees of the Standard Oil Company of Indiana.

Professor Frank C. Whitmore, dean of Pennsylvania State College, spoke on "Ipatieff—His Influence on World Chemistry." Professor Ipatieff discussed "My Twelve Years in the U. S. A." Dr. Egloff spoke on "Ipatieff's Influence on Industry," and Professor Ward V. Evans, professor of chemistry at Northwestern University, paid a tribute to "Ipatieff, the Scholar."

Professor Ipatieff, who is director of chemical research of Universal Oil Products Company, was born in Russia. During the first World War, he was a general in the Czar's army, in charge of all chemical activities. He became an American citizen, however, as soon as he was eligible after coming to the United States.

Chemical processes based on his inventions and discoveries are now producing products from petroleum that are vital for the winning of the war.

The professor is the author of many scientific books and articles, and has been granted many patents.

Numerous honors have been awarded him by various scientific societies and institutions in this country and abroad.

## Bibliography on Carbon Black

The Technical Department of the Tulsa Public Library has recently issued a bibliography on carbon black. This is the library's Petroleum Bibliography No. 8.

## H. W. Fletcher Passes Away

Harold W. Fletcher, vice-president and general manager of Hughes Tool Company, Houston, Texas, died October 15. He was 51 years old.

Fletcher graduated from Cornell University in 1915 with a degree in mechanical engineering. During the next

H. W. FLETCHER

year he was affiliated with the Rock Tunneling Machine Corporation, after which he entered the employ of the Hughes Tool Company as an engineer. He became chief engineer in 1918 and occupied that post until he was made vice-president and general manager three years ago.

He was a member of the American Society of Mechanical Engineers, the American Society of Metals, the American Institute of Mining and Metallurgical Engineers, the American Petroleum Institute, and the Sigma Xi fraternity.

## H. V. Putman New Vice-President Westinghouse

H. V. Putman, manager of the company's Transformer Division has been elected to the rank of vice-president by the board of directors of the Westinghouse Electric and Manufacturing Company.

Putman was appointed manager of the Westinghouse Transformer Division in November, 1940. Transformer production to meet the requirements of expanding war industries and power stations has more than doubled in the last two years.

Putman was born in Barker, New York, in 1899. He was graduated from Union College, Schenectady, New York, in 1920, with the degree of bachelor of science in electrical engineering. In 1921 he recieved his master's degree from Union College, and the degree of doctor of philosophy in 1923.

Two years after completing his college work, he joined Westinghouse as a design engineer on synchronous motors, at the Westinghouse East Pittsburgh works. As section engineer in charge of synchronous motor design he developed the simplex synchronous motor that is adaptable to all low-speed drives requiring high-starting torques with low-starting current.

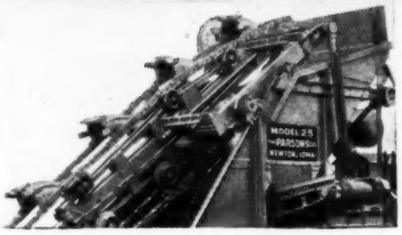
In 1930, Putman was transferred to Sharon as assistant manager of the Transformer Division's engineering department and two years later was promoted to manager of engineering.

In April, 1939, he received the Westinghouse Order of Merit for distinguished service. The award, voted by the company's board of directors, consists of a bronze medal bearing a silver "W", and a citation: "For the thoroughness of his engineering ability; for his vision in product development; for his high qualities as a leader, and for his ability to bring a broad and rich experience to bear on new problems."

## Harry Heller a Grandfather

Congratulations are in order for Harry Heller, advertising manager of Reed Roller Bit Company, Houston, Texas, who recently became a grandfather. Heller's daughter gave birth to a son on October 28.


PARSONS



OFFSET BOOM TRENCHING SAVES TIME

Avoid costly hand excavation on difficult trenching by using a Parsons Trencher. • The offset boom, standard on Parsons Trenchers, makes it easy to dig close to steep banks, near trees or poles and next to curbing. The trench may be cut on line with the outside edge of either crawler just as efficiently as with the boom in center position. • It takes but a few minutes to shift the boom to any position across the width of chute. The shift is positive through its rack and pinion mechanism and the boom is held solidly with heavy bolts through boom and carriage frame. • This is only one of the superior Parsons features.

THE PARSONS CO • NEWTON, IOWA

TRENCHING EQUIPMENT

## W. F. Huff Resigns From OPC

William F. Huff, special consultant to the Deputy Petroleum Coördinator for War, has resigned to return to private business in California, Deputy Petroleum Coördinator Ralph K. Davies announces. Well-known in the oil industry as a materials expert, Huff joined OPC in January, 1942, when he was appointed director of the then newly created Division of Materials. In July, Huff was relieved of administrative duties to devote his entire time to the preparation of a petroleum industry materials inventory program.

"With my work now completed, I feel that a return to my private business activities will permit me to be of greater service to the war program," Huff wrote in his letter of resignation. "Please consider me as being at your disposal for any future consultation which you may deem desirable."

Huff, a native of Texas, began a career in public utilities with the Pacific Telephone and Telegraph Company, when World War I interrupted this work. Enlisting as a private, he served in the Army for 18 months, winning promotion to the rank of second lieutenant. After the war, he served in various capacities in the production of petroleum and in 1921 he went to the National Supply Company, serving as assistant sales manager and as western export sales manager. He left that company in 1935 to become vice-president and secretary-treasurer of the Bettis Rubber Company. In 1938, he went to the Petroleum Equipment Company as manager of tubular sales, remaining with that firm until going with the Coördinator's Office. His home is in Glendale, California.

## Completes 30 Years' Service

E. J. Hammerly, salesman in the Philadelphia district of the Industrial Products Sales division of The B. F. Goodrich Company, completed 30 years of service with his organization in October.

Hammerly began work with B. F. Goodrich on October 14, 1912, as a clerk in the Akron headquarters office, and four years later began his sales career. He has been on the staff of the Industrial Products Sales division in the Philadelphia district since 1917.

## Fluid Packed Pump Company Makes Appointments

Fluid Packed Pump Company announces the appointment of Sidney Shuman as general sales manager for the Mid-Continent Division and John Ruff as assistant manager.

SIDNEY SHUMAN

Shuman joined Fluid Packed Pump Company in 1936 after having spent many years in the services of the Sinclair Prairie Oil Company. "Sid" has been a familiar figure in representing the Fluid Packed Pump Company in the


# BIG ENOUGH to do a BIG JOB!

• This huge American bomber carries a large load a long distance—and does a job no smaller plane can do.

• Size is America's salvation today in other ways as well. The size of our land and its rich resources. The size of our great production plants. *And the size of the electric industry that powers the machines that makes planes, tanks, guns and ships.*

• Like other American industries, the electric industry gained its size, skill and experience under the free democratic system for which we're fighting. It grew by supplying better and better service to more and more people at lower and lower price—building on the invested savings of millions of Americans — under practical business management and public regulation.

• Because the electric companies were *ready* when war came — because no war plant had to wait for power — precious time was saved for Victory. How big should an electric company be? *Big enough to do the job, right around the clock and the calendar.*

**SOUTHWESTERN GAS AND ELECTRIC CO.**

E-2024

fields adjacent to Seminole, Shreveport, Smackover, Kilgore, Oklahoma City, and Tulsa. He will continue to make his headquarters in the Divisional Sales Office, Hunt Building, Tulsa, Oklahoma.

John Ruff has been with the company for the last three years devoting his time to the Texas fields. For 15 years prior to that Ruff represented the

JOHN RUFF

Jarecki Supply Company in southern Kansas, northern Oklahoma, and at Kilgore, Texas. Ruff will take up his duties and make his headquarters at the Southern Division Sales Office, 6006 Navigation Boulevard, Houston, Texas.

Ora Frame, who formerly headed Fluid Packed Pump Company's Southern Division, is now in the service with the United States Marine Corps.

## C. D. Lockwood Named To OPC Staff

C. D. Lockwood of Houston, Texas, has been named assistant director in the Office of Petroleum Coördinator's Research Division, Deputy Coördinator Ralph K. Davies announces. Edward B. Swanson is Director of Research.

In 1931 and 1932, Lockwood traveled in Europe and Asia, visiting the oil fields of Russia, Iran, Iraq, Rumania, Italy, and Germany. During this time he wrote articles for the *National Petroleum News*. He is the author of two books on oil fields in the Texas and Louisiana Gulf Coast, and is the former publisher of the *Lockwood Daily Oil Report*. During the first World War, he served with the American Expeditionary Forces.

Lockwood was born February 4, 1899, at McFall, Missouri, was graduated from the University of Missouri's School of Journalism, and worked for the *Oil and Gas Journal* from 1923 to 1927.

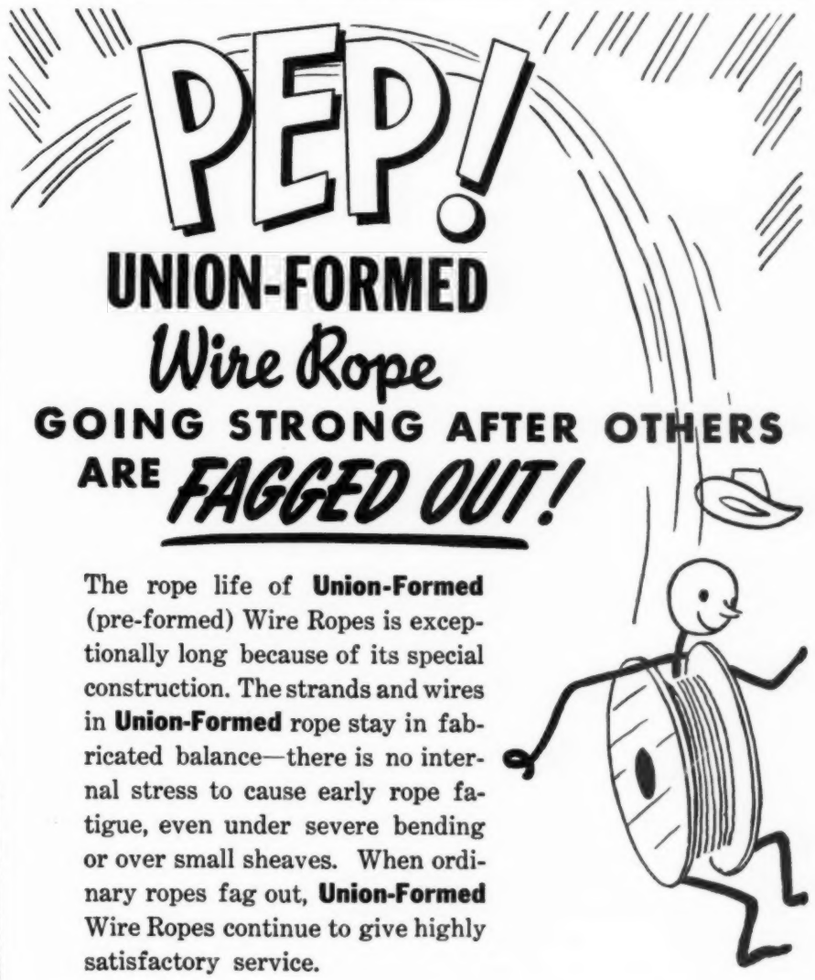
Prior to joining OPC, Lockwood disposed of his *Daily Oil Report*.

OPC's new assistant research director replaces Oliver S. Ambrose, who returned to Tide Water Associated Oil Company.

## Death of Dr. Holweck

Knowledge of the death in a Paris prison December 14, 1941, of Dr. Fernand Holweck has only recently reached the United States. Dr. Holweck was director of research of the "Centre National de la Recherche Scientifique" and associate professor of physics at the Institute of Radium of the Sorbonne (Laboratory Curie).

Born in 1889, he was graduated in physics from the "Ecole de Chimie et Physique of Paris. He became assistant to Madame Curie in 1912. His scientific achievements are many. In the field of geophysics he is known for the Holweck gravimetric pendulum, which he brought to a high state of perfection in coöperation with Lejay.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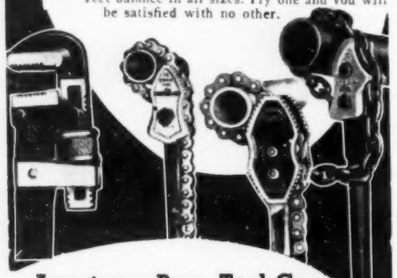

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## Wickwire Spencer Receives Maritime Award

The Palmer Plant of the Wickwire Spencer Steel Company at Palmer, Massachusetts, has been awarded the Maritime "M" Pennant and Victory Fleet Flag. The award was given for "outstanding production achievement" on cables and riggings for America's Victory Fleet of cargo ships.

The presentation address was made by the Honorable Thomas M. Woodward, United States Maritime Commissioner.

Approximately 1500 employees and 1500 guests from the near-by community attended.

It was the first Maritime "M" to be awarded anywhere in New England.

Acceptance for the Commonwealth of Massachusetts was made by the Honorable Leverett Saltonstall, Governor. Acceptance for the company was by Carl I. Collins, executive vice-president. Acceptance for employees was by Henning W. Forsman honoring his 42 years' service at the Palmer plant.

Flag Honor Guards were Walfred Peterson and Frank Blair honoring their 30 and 28 years of service at the Palmer plant.

Master of ceremonies was Carl King, superintendent of the Palmer plant.

The program was broadcast over the Yankee Network from 2:45 to 3:15 p. m.

Superintendents of all other Wickwire Spencer plants attended; also other executives of the company.

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in the elimination and prevention of boiler scale and corrosion.

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**NATIONWIDE SALES AND STOCKS**

*Honorable Leverett Saltonstall, governor of Massachusetts, making address*

## Army-Navy "E" Presented to National Supply

The Army-Navy "E", joint Army and Navy production award, was presented to the Ambridge, Pennsylvania, plant of The National Supply Company recently before a crowd of approximately 6000, comprised of more than 2200 employees and their families.

Principal speaker on the program, which was broadcast over KDKA, Pittsburgh, was Brigadier General Hugh C. Minton, District Chief of the Pittsburgh Ordnance District. He presented the "E" Pennant to A. E. Walker, National Supply's president. Lieutenant Commander C. E. Egeler, Officer in charge of Naval Inspection for the Munhall (Pittsburgh) area, awarded the first Army-Navy "E" pin to oldest employee, A. D. Adams.

An interesting highlight of the event was the appearance on the program of Lieutenant Dick Adams (USNR), son of the oldest employee, who had just returned on furlough from active duty in the Pacific area.

Ford Bond, well-known N.B.C. announcer, acted as master of ceremonies of the program.

*A. D. Adams, oldest employee of the Ambridge, Pennsylvania, plant of The National Supply Company, accepts the award of the Army-Navy "E" pins to employees. To left of Adams is A. E. Walker, National Supply president*

## G-E Appointments

D. L. Beeman has been appointed engineer, Industrial Power Section, succeeding E. G. Merrick, and R. S. Sage has been named engineer, Mining Section, succeeding F. L. Stone of General Electric Company's Industrial Engineering Department.

It is also announced that the petroleum industry application engineering responsibilities have been transferred from the Mining Section to the Chemical Section headed by T. R. Rhea. This section will now be called the Petroleum and Chemical section.

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Manufacturer of

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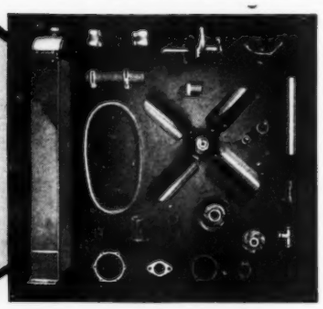
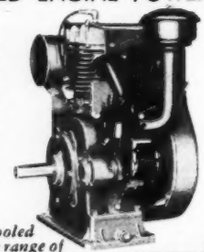


In the promotion of today's urgent war effort, *manufacturers, sellers,* and *users* of power-operated equipment (within a 1 to 35 hp. range) can effect substantial savings of critical materials, labor, and machine work at the *manufacturing source* by specifying WISCONSIN AIR-COOLED ENGINE POWER.

These heavy-duty engines require none of the 26 parts illustrated above, which comprise the cooling system of a typical water-cooled engine . . . parts that also require periodical servicing and replacement. One simple flywheel-fan casting replaces all of these parts. And there are no water chores or troubles to worry about.



*Wisconsin Heavy-Duty Air-Cooled Engines are made in a complete range of types and sizes, 1 and 4 cyl., 1 to 35 hp. Illustrated is the AHH Single Cyl. Engine.*

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# TRADE LITERATURE

## What to Write For

AMERICAN METER COMPANY, INC., Erie, Pennsylvania, is offering free their Bulletin E-22, which discusses the Air-Actuated Remote Recorder and Controller, "a rugged yet sensitive device for the recording and control of pressures, rates of flow, and liquid levels—over any distance." This Metric-American instrument has helped many operators perfect the desired well-coördinated system of centralized control, the manufacturer states.

AXELSON SERVICE MANUAL gives complete information on how to take an Axelson Pump apart, what to look for in the nature of wear or essential adjustment, how properly to order replacement parts, and how properly to reassemble Axelson Pumps. The company offers the manual free upon request. Address Axelson Manufacturing Company, P. O. Box 98, Vernon Station, Los Angeles, California.

THE COOPER-BESSEMER CORPORATION, Mount Vernon, Ohio, offers Bulletin G-MV, which describes type G-MV Compressors. G-MV's are engineered to stand the toughest kind of service that determined workers can put them to, the manufacturer states. Oil-cooled pistons, Silent-Scot fuel injection, full-pressure lubrication, precision-type and oversize bearings on oversize crankshafts, crankpins and wristpins are some of the features of the equipment.

EDWARD CATALOG NO. 101 gives detailed description and dimensions of standard Edward valves and how they cut delivery time. These forged and cast-steel valves fit a wide variety of power, petroleum, process piping, and industrial services. Address The Edward Valve and Manufacturing Company, Inc., 1592 West 145th Street, East Chicago, Indiana, for a copy of this catalog.

LE ROI COMPANY, Milwaukee, Wisconsin, offers free its bulletins PA, PE3, and PE176, describing the features of Le Roi's engines. These engines are economical to operate with natural gas, gasoline, or butane, and are all fully enclosed for protection against tampering or bad weather, the manufacturer asserts.

BULLETIN WF-41 gives facts regarding Midwest Butt-Welding Elbows. Qualified pipe welders report that Midwest Elbows save time and trouble on the job because they are always uniform—and because they are always accurately to dimension, the makers state. Address the Midwest Piping and Supply Company, Inc., 1450 South Second Street, St. Louis, Missouri, for a copy of the bulletin.

PENBERTHY INJECTOR COMPANY, Detroit, Michigan, offers free its Catalog 34A containing complete information on Penberthy Reflex Gages. These gages are made in whatever lengths required and for various liquids; they conform with A.P.I.-A.S.M.E. requirements and are recommended for pressures up to 3000 lb. per sq. in. at 100°F., and 1000 lb. at 1000°F.

TUBE TURNS, INC., Louisville, Kentucky, has issued their new complete catalog and valuable engineering data book No. 111. It's free upon writing the company.

BULLETINS TU-180 and TU-181 illustrating and describing the complete line of Wagner Transformers are offered free

by Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis, Missouri. Wagner transformers can be supplied with junction boxes, "tailored" to meet any installation requirement, it is stated.

BULLETIN 1079 issued by Waukesha Motor Company, Waukesha, Wisconsin, gives a complete list of Waukesha oil-field engines with ratings—speed, torque, horsepower, and size. This bulletin is free upon request.

THE BROWN INSTRUMENT COMPANY has published a 64-page booklet entitled, "The Technique of Precision Control in Industrial Processes." This booklet has been prepared to acquaint engineers, operators, and management with the manifold applications of automatic control to industrial processes. A copy of this booklet will be sent upon request. Write to the Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania, and ask for Booklet 80-1.

A DESCRIPTION OF A LINE of Universal Controllers for temperature control applications is given in Vol. 2, No. 2 of Wheelco Comments, issued by Wheelco Instruments Company, Harrison and Peoria Streets, Chicago. The publication describes pyrometers, potentiometers, and thermometers with unit construction features that permit ready removal of each component for inspection, repair and replacement, thereby eliminating the necessity of ever removing the instrument from service. Also discussed are design features that permit convenient conversion of one model to another, such as a pyrometer to a potentiometer, etc. The electronic principle of effecting temperature control without mechanical contact between measuring and control components of the instruments is described, and all features are illustrated.

IN BULLETIN A-321, The Foxboro Company, Foxboro, Massachusetts, presents its Operation-Time Recorders, both electric-operated and mechanical, and explains the application of such instruments to the processes of various industries. Their importance in test engineering, in setting job standards, and in cost accounting and production control is discussed, and diagrams show typical installations of recorders for several different kinds of work. Complete specifications are included, for single-and multiple-pen instruments. Copies of the bulletin will be sent on request.

"AAF IN INDUSTRY" is the title of a bulletin recently issued by the American Air Filter Company, Louisville, Kentucky. The publication discusses in detail air filtration and dust control in industrial plants and is free upon request.

PACIFIC PUMP WORKS, Huntington Park, California, has published a bulletin giving the story of Pacific's part in the pump industry. The bulletin may be had by writing the manufacturer.

**Statement of the Ownership, Management, etc., of THE PETROLEUM ENGINEER**
**October 1, 1942**

(This statement is published in compliance with the Act of August 24, 1912.)

Published at Dallas, Texas, monthly August through June, semi-monthly in July.
Publisher: The Petroleum Engineer Publishing Co., Dallas, Texas.
Editor: K. C. Sclater, Dallas, Texas.
Managing Editor: F. H. Love, Dallas, Texas.
Business Manager: W. T. Bryan.
Stockholders holding 1 per cent or more of total amount of stock: C. R. Barrett, W. T. Bryan, T. J. Crowley, W. L. Love, K. C. Sclater, Dallas, Texas.
Known bondholders, mortgagees and other security holders holding 1 per cent or more of the total amount of bonds, mortgages or other securities: None.
W. T. Bryan, Secretary-Treasurer.
Sworn to and subscribed before me this 1st day of October, 1942.
Frances Haley, Notary Public.
(My commission expires June, 1943.)

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# Book Reviews

*Flush Production: The Epic of Oil in the Gulf-Southwest*, by Gerald Forbes. Published by The University of Oklahoma Press Publishing Division of the University, Norman, Oklahoma. Price $2.25.

According to Forbes' research, no other producing area is so closely identified with or so highly colored by the oil business. Effective production was largely instrumental in transforming the Southwest from a raw frontier country to an industrial empire in less than a lifetime. Daring "wildcatters," who drilled where no one had drilled before, took their places with the heroes of frontier history. Those who failed frequently made comebacks in a short time, to earn a place in oil history.

Forbes, a newspaper man of long experience in the Southwest and a trained historian, began his investigations five years ago. His history deals with all phases of oil development in the six states of Kansas, Oklahoma, Texas, Arkansas, Louisiana, and New Mexico from the year of the first effective production in 1886 until the present.

He points out that, although the Klondike and California gold rushes have become popular legends of quick wealth, the oil production of the Southwest has long since distanced both in actual fact. And contrary to popular belief, the price of oil was higher in the first five years than at its supposed peak during the first World War. Before production began, oil obtained from natural seepages sold for not less than $5.00 a bbl. The price during the depression went as low as 10 cents.

Names of the pools which beckoned investors from all over the world and called for feverish activity on the part of the drillers and producers are frequent in the book.

## A.I.M.E. Meets in Los Angeles

As it must at all meetings, the importance of the petroleum industry to the war effort was brought out at the meeting of the American Institute of Mining and Metallurgical Engineers held in Los Angeles, October 15 and 16, 1942. Eighteen papers were presented during the technical sessions[1] and these made a valuable contribution to the literature on theory and practice of oil production.

The speaker at the Stag Dinner held at the Ambassador Hotel on Friday evening the 16th was J. H. Marsman who, having spent more than 25 years on engineering work in the Far East, discussed "The Orient at War". Present from New York were Chester Naramore, executive secretary of the Petroleum Division, and E. J. Kennedy, assistant to the secretary of the Institute.

Tying in definitely with the war effort was the "Symposium on Recovery as Affected by Production Techniques", which consisted of seven papers and the discussions on the points brought out in those papers. A general outline of the problems attending the increase of recovery was first given by Everett G. Trostel who, in his conclusion, stated "The purpose of this discussion has been to render you gentlemen 'recovery conscious' and thereby pave the way for the papers to follow. The problems of increasing recovery is not one of pure theory. It is a practical one which pays off in dollars and cents. Current production practice probably leaves behind an average residual oil representing 70 percent or more of the oil originally in place. Recovery of an increasing fraction of this oil presents a challenge to the engineering talent of the industry. During normal peace-time conditions this challenge should not go unheeded; it is a 'must' during war."

[1] A report of the meeting with list of papers was published in the October issue of *The Petroleum Engineer*.

# MEETINGS

American Chemical Society, National Chemical Exposition and National Industrial Chemical Conference—November 24, 25, 26, 27, 28, and 29, Sherman Hotel, Chicago, Illinois.

American Society of Mechanical Engineers, Annual Meeting—November 30 and December 1, 2, 3, and 4, New York, New York.

New Mexico Oil and Gas Association—December 2, Artesia Hotel, Artesia, New Mexico.

California Natural Gasoline Association, Monthly Meeting—December 3, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

American Institute of Mining and Metallurgical Engineers, Annual Meeting—February 15, 16, 17, and 18, 1943, New York, New York.

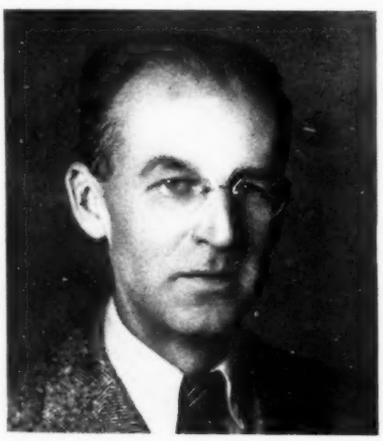
American Association of Petroleum Geologists, Annual Meeting—April 7, 8, and 9, Fort Worth, Texas.

American Petroleum Institute, Division of Production, Eastern District—April 8 and 9, 1943, William Penn Hotel, Pittsburgh, Pennsylvania.

Petroleum Industry Electrical Association, Annual Meeting—May 5 and 6, Houston, Texas.

## W. S. Clute Assigned Post with A.I.M.E.

Upon the resignation of Walter Abel as secretary-treasurer of the Southern California Section of the American Institute of Mining and Metallurgical Engineers, Walker S. Clute was appointed by C. P. Watson, chairman of the Section, to fill that office. Abel's resignation was caused by his recent acceptance of a position with the R.F.C., which will require his absence from California for a considerable part of the time.



W. S. CLUTE

Walker S. Clute maintains an office as consulting petroleum geologist and engineer in Los Angeles and has conducted oil exploration work in many parts of the United States and in Colombia, South America. At one time he was drilling and production superintendent in Wyoming fields and for some time was with the U. S. Treasury Department in the income tax division as valuation engineer. Later he served in the U. S. Geological Survey in Washington and Tulsa. Clute was graduated from Leland Stanford University in 1915.

## New Chapter of B. F. Goodrich Clubs

Forty-four veteran employees whose total service amounts to 1100 years with the B. F. Goodrich Company have organized a Pacific Coast Chapter of the Akron company's Twenty-Year Club, it is announced by Al Hupfer, national president of the group.

Hupfer said the membership of all chapters totals approximately 3600 employees who have each been with the company from 20 and 50 years. He said the organization's first chapter was founded in 1934, with 700 charter members.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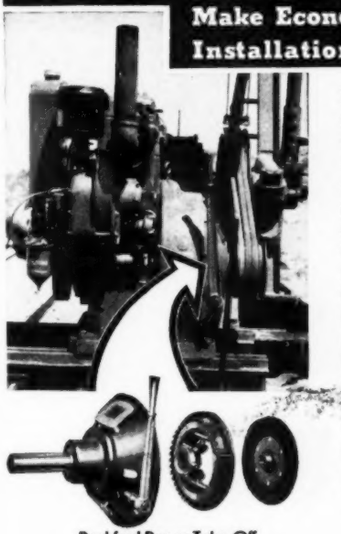

Rockford Power Take-Offs and Plate Clutches are extensively used in power units because their economy, high quality, and consistently fine performance promote maximum advantages all around. The 15 h.p. Diesel pumping unit illustrated has a Rockford Power Take-Off with Over-Center Clutch . . . a great performance combination on small engines as well as those for the heavier services. Our Spring-Loaded Clutches can also be furnished for similar applications when automobile-type control is indicated.

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The Wheatley Streamlined Strainer fits directly into the line eliminating all drop pressure. The necessity of digging a pit, as is customary when installing the old vertical type, is also eliminated.

The galvanized basket sits on lugs cast in the Strainer Body, allowing ample room all around the basket and end of the Strainer to permit full flow. The Basket is off center to allow reservoir to hold scale and debris.

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